214

PROCEEDINGS

OF THE

THIRTY-FIRST MEETING

OF THE

BRITISH ASSOCIATION

FOR THE

ADVANCEMENT OF SCIENCE;

HELD AT

MANCHESTER, SEPTEMBER 4TH TO 11TH, 1861.

Reprinted from the "Manchester Guardian."

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PRINTED AT THE "GUARDIAN" STEAM-PRINTING OFFICES, 3, CROSS STREET.
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INTRODUCTION.

It is now thirty years since the British Association for the Advancement of Science held its first meeting in the city of York. Like most great and meritorious enterprises, it had a comparatively humble beginning; but its originators were brave, earnest men, who unflinchingly adhered, in good report and in evil report, to their noble scheme, which was designed "to give a stronger impulse and a more systematic direction to scientific inquiry,—to promote the intercourse of those who cultivate science in different parts of the British Empire with one another, and with foreign philosophers,—and to obtain a more general attention to the objects of science, and a removal of any disadvantages of a public kind which impede its progress." It is not too much to say that, ever since 1831, the Association has steadily applied itself to the fulfilment of this useful mission, that its history up to the present time is a record of progressive success in the objects it contemplates,—and that in each successive year, it has acquired additional power and influence. As we have stated, the first session of this distinguished body was held at York, in 1831; Lord Fitzwilliam, President.

Meeting and Place.	President.	Meeting and Place.	President.
The 2nd was held at Oxford	Dr. Buckland.	The 17th at Oxford	Sir. R. H. Inglis.
The 3rd at Cambridge	Professor Sedgwick.	The 18th at Swansea	The Marquis of Northampton.
The 4th at Edinburgh	Sir T. M. Brisbane.	The 19th at Birmingham	Dr. Robinson.
The 5th at Dublin	Dr. Lloyd.	The 20th at Edinburgh	Sir David Brewster.
The 6th at Bristol	Lord Lansdowne.	The 21st at Ipswich	The Astronomer Royal.
The 7th at Liverpool	Lord Burlington.	The 22nd at Belfast	Colonel (now General) Sabine.
The 8th at Newcastle-on-Tyne	The Duke of Northumberland.	The 23rd at Hull	Mr. Hopkins.
The 9th at Birmingham	The Rev. W. Vernon Harcourt.	The 24th at Liverpool	Lord Harrowby.
The 10th at Glasgow	The Marquis of Breadalbane.	The 25th at Glasgow	The Duke of Argyll.
The 11th at Plymouth	Dr. Whewell.	The 26th at Cheltenham	Dr. Daubeny.
The 12th at Manchester	Lord Ellesmere.	The 27th at Dublin	Dr. Lloyd.
The 13th at Cork	Lord Rosse.	The 28th at Leeds	Professor Owen.
The 14th at York	The late Dean Peacock, of Ely.	The 29th at Aberdeen	The Prince Consort.
The 15th at Cambridge	Sir John Herschel.	The 30th at Oxford	Lord Wrottesley.
The 16th at Southampton	Sir Roderick Murchison.	The 31st at Manchester	Mr. William Fairbairn.

Cambridge has been selected for the meeting of next year, the Presidential chair to be occupied by Professor Willis.

In 1831, as appears from the official records, the Association commenced a system of grants of money, for scientific purposes. The sum paid in that year in this way, was a very modest one, £20. Next year, it was £167; in 1836, it mounted up to £434. 14s.—

	£	s.	d.		£	s.	d.
In 1837 it was	918	14	6	In 1849	159	19	6
In 1838	956	12	2	In 1850	345	18	0
In 1839	1,595	11	0	In 1851	391	9	7
In 1840	1,546	16	4	In 1852	304	6	7
In 1841	1,235	10	11	In 1853	205	0	0
In 1842	1,449	17	8	In 1854	380	19	7
In 1843	1,565	10	2	In 1855	480	16	4
In 1844	981	12	8	In 1856	734	13	9
In 1845	830	9	9	In 1857	507	15	4
In 1846	685	16	0	In 1858	618	18	2
In 1847	208	5	4	In 1859	684	11	1
In 1848	275	1	8	In 1860	1,241	7	0

While, in the year 1860-61, the outlay for scientific purposes was upwards of £1,100. This gives the large total of more than £20,000, expended under the direction of a body necessarily better fitted than any other in this country to suggest and control investigations in the interest of science.

The Manchester meeting of 1861 has been a marked success. Taking the average of thirty years, the number of members at each annual gathering may be set down at 1,600, and the receipts at something under £2,000. The present meeting, however, boasts upwards of 3,000 members, and receipts to the amount of £3,920. In 1842, when the Association first honoured Manchester with a visit, the number of members was 1,316, and the amount of the receipts £2,161. Looking, therefore, at attendance and revenue, the Association and Manchester must be congratulated upon the results of the meeting just brought to a close; and it is only necessary to scan the contents of this little volume to find satisfactory evidence of the high value of the papers which have been read, and of the discussions which have taken place, in the various sections.

September, 1861.

BRITISH ASSOCIATION

FOR THE

ADVANCEMENT OF SCIENCE.

MEETING IN MANCHESTER, FROM 4TH TO 11TH SEPT., 1861.

WEDNESDAY, SEPT. 4.

The first general meeting was held in the evening, in the Free-trade Hall; there being fully 2,000 members, associates, and ladies present.

Lord Wrottesley, the president of the past year, and William Fairbairn, Esq. LL.D. F.R.S.' the president elect, came upon the platform about eight o'clock, at which time the hall was crowded.

Lord WROTTESLEY took the chair amidst applause. He said: In retiring from the office which I have the honour to hold, it is a great pleasure to me to know that I am to be succeeded by one who is so well worthy of your support. We may derive important instruction from the career of Mr. Fairbairn, whether we view him as a successful engineer or as a distinguished man of science. In the former capacity he is one who, by perseverance, combined with talent, has risen from small beginnings to the summit of his profession; and he forms one of that noble class of men, the Stephensons, the Brunels, the Whitworths, and the Armstrongs, who have conferred such important services upon their country; and some of whom, unfortunately for that country, have perished, alas! too soon, exhausted by their arduous toils. Mr. Fairbairn, therefore, is one of the many examples of what can be done in England, by a man who resolves, undaunted by the difficulties and obstructions that beset his path, to struggle gallantly on until success crowns his efforts. Again, if we look to Mr. Fairbairn's claims to scientific distinction, they read to us an important lesson; for they show what can be done by zeal and energy, exercised by a strong and resolute will, fully determined to carry out an object in which the public is deeply interested. It is extraordinary that any one should have been able, during the few hours snatched from an important and engrossing business, to accomplish for science what Mr. Fairbairn has done. — (Applause.) Not only has he been a most successful contributor to mechanical science, but his liberality has been unbounded in placing all his great mechanical resources at the disposal of his fellow-labourers in the same field. Well and truly was it said, when the royal medal was conferred upon Mr. Fairbairn for his researches—(applause)—well and truly was it said that perhaps there is scarcely a single individual living who has made so many and so careful experimental inquiries on subjects of primary importance to the commercial and manufacturing interests of the country, and who has so liberally contributed them to the world at large.—(Applause.) Such are men whom we should all delight to honour; and to such a man I resign, with great satisfaction, the chair which I now vacate.—(Applause.)

WILLIAM FAIRBAIRN, Esq. LL.D. F.R.S. on taking the chair, was received with hearty applause. On its ceasing, he proceeded to deliver the following address:—

Ever since my election to the high office I now occupy, I have been deeply sensible of my own unfitness for a post of so much distinction and responsibility. And when I call to mind the illustrious men who have preceded me in this chair, and see around me so many persons much better qualified for the office than myself, I feel the novelty of my position and unfeigned embarrassment in addressing you. I should, however, very imperfectly discharge the duties which devolve upon me, as the successor of the distinguished nobleman who presided over the meetings of last year, if I neglected to thank you for the honourable position in which you have placed me, and to express, at the outset, my gratitude to those valued friends with whom I have been united for many years in the labours of the sections of this Association, and from whom I have invariably received every mark of esteem.

A careful perusal of the history of this Association will demonstrate that it was the first and for a long time the only institution, which brought together for a common object the learned professors of our universities, and the workers in practical science. These periodical reunions have been of incalculable benefit, in giving to practice that soundness of principle and certainty of progressive improvement which can only be obtained by the accurate study of science and its application to the arts. On the other hand, the men of actual practice have reciprocated the benefits thus received from theory, in testing by actual experiment deductions which were doubtful, and rectifying those which were erroneous. Guided by an extended experience, and exercising a sound and disciplined judgment, they have often corrected theories apparently accurate, but nevertheless founded on incomplete data, or on false assumptions inadvertently introduced. If the British Association had effected nothing more than the removal of the anomalous separation of theory and practice, it would have gained imperishable renown in the benefit thus conferred. Were I to enlarge on the relation of the achievements of science to the comforts and enjoyments of man, I should have to refer to the present epoch as one of the most important in the history of the world. At no former period did science contribute so much to the uses of life and the wants of society. And in doing this it has only been fulfilling that mission which Bacon, the great father of modern science, appointed for it, when he wrote that "the legitimate goal of the sciences is the endowment of human life with new inventions and riches," and when he sought for a natural philosophy which, not spending its energy on barren disquisitions, "should be operative for the benefit and endowment of mankind."

Looking, then, to the fact that, whilst in our time all the sciences have yielded this fruit, engineering science, with which I have been most intimately connected, has pre-eminently advanced the power, the wealth, and the comforts of mankind, I shall probably best discharge the duties of the office I have the honour to fill, by stating as briefly as possible the more recent scientific discoveries which have so

influenced the relations of social life. I shall, therefore, not dwell so much on the progress of abstract science, important as that is, but shall rather endeavour briefly to examine the application of science to the useful arts, and the results which have followed, and are likely to follow, in the improvement of the condition of society. The history of man throughout the gradations and changes which he undergoes in advancing from a primitive barbarism to a state of civilisation, shows that he has been chiefly stimulated to the cultivation of science and the development of his inventive powers, by the urgent necessity of providing for his wants and securing his safety. There is no nation, however barbarous, which does not inherit the germs of civilisation, and there is scarcely any which has not done something towards applying the rudiments of science to the purposes of daily life. Amongst the South Sea Islanders, when discovered by Cook, the applied sciences—if I may use the term—were not entirely unknown. They had observed something of the motions of the heavenly bodies, and watched with interest their revolutions, in order to apply this knowledge to the division of time. They were not entirely deficient in the construction of instruments of husbandry, of war, and of music. They had made themselves acquainted with the rudiments of shipbuilding and navigation, in the construction and management of their canoes. Cut off from the influence of European civilisation, and deprived of intercourse with higher grades of mind, we still find the inherent principle of progression exhibiting itself, and the inventive and reasoning powers developed in the attempt to secure the means of subsistence. Again, if we compare man as he exists in small communities with his condition where large numbers are congregated together, we find that densely-populated countries are the most prolific in inventions, and advance most rapidly in science. Because the wants of the many are greater than those of the few, there is a more vigorous struggle against the natural limitations of supply, a more careful husbanding of resources, and there are more minds at work. This fact is strikingly exemplified in the history of Mexico and Peru, and its attestation is found in the numerous monuments of the past which are seen in Central America, where the remains of cities and temples, and vast public works, erected by a people endowed with high intellectual acquirements, can still be traced. There have been discovered a system of canals for irrigation; long mining galleries cut in the solid rock, in search of lead, tin, and copper; pyramids not unlike those of Egypt; earthenware vases and cups, and manuscripts, containing the records of their history; all testifying to so high a degree of scientific culture and practical skill, that looking at the cruelties which attended the conquests of Cortes and Pizarro, we may well hesitate as to which had the stronger claims on our sympathy, the victors or the vanquished.

In attempting to notice those branches of science with which I am but imperfectly acquainted, I shall have to claim your indulgence. This Association, as you are aware, does not confine its discussions and investigations to any particular science; and one great advantage of this is, that it leads to the division of labour, whilst the attention which each department receives, and the harmony with which the plan has hitherto worked, afford the best guarantee of its wisdom and proof of its success.

In the early history of astronomy, how vague and unsatisfactory were the wild theories and conjectures which supplied the place of demonstrated physical truths and carefully observed laws? How immeasurably small, what a very speck does man appear, with all the wonders of his invention, when contrasted with the mighty works of the Creator; and how imperfect is our apprehension, even in the highest flights of poetic imagination, of the boundless depths of space? These reflections naturally suggest themselves in the contemplation of the works of an Almighty Power, and impress the mind with a reverential awe for the Great Author of our existence. The great revolution which laid the foundation of modern astronomy, and which, indeed, marks the birth of modern physical science, is chiefly due to three or four distinguished philosophers. Tycho Brahe, by his system of accurate measurement of the positions of the heavenly bodies; Copernicus, by his theory of the solar system; Galileo, by the application of the telescope; and Kepler, by the discovery of the laws of the planetary motions, all assisted in advancing, by prodigious strides, towards a true knowledge of the constitution of the universe. It remained for Newton to introduce, at a later period, the idea of an attraction varying directly as the mass, and inversely as the square of the distance, and thus to reduce celestial phenomena to the greatest simplicity, by comprehending them under a single law. Without tracing the details of the history of this science, we may notice that in more recent times astronomical discoveries have been closely connected with high mechanical skill in the construction of instruments of precision. The telescope has enormously increased the catalogue of the fixed stars, or those "landmarks of the universe," as Sir John Herschel terms them, "which never deceive the astronomer, navigator, or surveyor." The number of known planets and asteroids has also been greatly enlarged. The discovery of Uranus resulted immediately from the perfection attained by Sir William Herschel in the construction of his telescope. More recently, the structure of the nebulæ has been unfolded through the application to their study of the collosal telescope of Lord Rosse. In all these directions much has been done both by our present distinguished Astronomer Royal, and also by amateur observers in private observatories, all of whom, with Mr. Lassells at their head, are making rapid advances in this department of physical science. Our knowledge of the physical constitution of the central body of our system seems likely, at the present time, to be much increased. The spots on the sun's disc were noticed by Galileo and his contemporaries, and enabled them to ascertain the time of its rotation and the inclination of its axis. They also correctly inferred, from their appearance, the existence of a luminous envelope, in which funnel-shaped depressions revealed a solid and dark nucleus. Just a century ago, Alexander Wilson indicated the presence of a second and less luminous envelope beneath the outer stratum, and his discovery was confirmed by Sir William Herschel, who was led to assume the presence of a double stratum of clouds, the upper intensely luminous, the lower grey, and forming the penumbra of the spots. Observations during eclipses have rendered probable the supposition that a third and outermost stratum of imperfect transparency encloses concentrically the other envelopes. Still more recently, the remarkable discoveries of Kirchoff and Bunsen require us to believe that a solid or liquid photosphere is seen through an atmosphere containing iron, sodium, lithium, and other metals in a vaporous condition. We must still wait for the application of more perfect instruments, and especially for the careful registering of the appearances of the sun by the photoheliograph of Sir John Herschel, so ably employed by Mr. Warren de la Rue, Mr. Welsh, and others, before we can expect a solution of all the problems thus suggested.

Guided by the same principles which have been so successful in astronomy, its sister science, magnetism, emerging from its infancy, has of late advanced rapidly in that stage of development which is marked by assiduous and systematic observation of the phenomena, by careful analysis and presentation of the facts which they disclose, and by the grouping of these in generalisations, which, when the basis on which they rest shall be more extended, will prepare the way for the conception of a general physical theory, in which all the phenomena shall be comprehended, whilst each shall receive its separate and satisfactory explanation. It is unnecessary to remind you of the deep interest which the British Association has at all times taken in the advancement of this branch of natural knowledge, or of the specific recommendations which, made in conjunction with the Royal Society, have been productive of such various and important results. To refer but to a single instance; we have seen those magnetic disturbances, so mysterious in their origin and so extensive in simultaneous prevalence—and which, less than twenty years ago, were designated by a term specially denoting that their laws were wholly unknown—traced to laws of periodical recurrence, revealing, without a doubt, their origin in the central body of our system, by inequalities which have for their respective periods, the solar day, the solar year, and still more re-

markably, an until lately unsuspected solar cycle of about ten of our terrestial years, to whose existence they bear testimony in conjunction with the solar spots; but whose nature and causes are in all other respects still wrapped in entire obscurity. We owe to General Sabine, especially, the recognition and study of these and other solar magnetic influences and of the magnetic influence of the moon similarly attested by concurrent determinations in many parts of the globe, which are now held to constitute a distinct branch of this science not inappropriately named "celestial," as distinguished from purely terrestial magnetism.

We ought not in this town to forget that the very rapid advance which has been made in our time by chemistry, is due to the law of equivalents, or atomic theory, first discovered by our townsman, John Dalton. Since the development of this law, its progress has been unimpeded, and it has had a most direct bearing on the comforts and enjoyments of life. A knowledge of the constituents of food has led to important deductions as to the relative nutritive value and commercial importance of different materials. Water has been studied in reference to the deliterious impurities with which it is so apt to be contaminated in its distribution to the inhabitants of large towns. The power of analysis, which enables us to detect adulterations, has been invaluable to the public health, and would be much more so if it were possible to obviate the difficulties which have prevented the operation of recent legislation on this subject. We have another proof of the utility of this science in its application to medicine; and the estimation in which it is held by the medical profession is the true index of its value in the diagnosis and treatment of disease. The largest developments of chemistry, however, have been in connection with the useful arts. What would now be the condition of calico printing, bleaching, dyeing, and even agriculture itself, if they had been deprived of the aid of theoretic chemistry? For example: Aniline—first discovered in coal tar by Dr. Hoffman, who has so admirably developed its properties—is now most extensively used as the basis of red, blue, violet, and green dyes. This important discovery will probably in a few years render this country independent of the world for dye stuffs; and it is more than probable that England, instead of drawing her dyestuffs from foreign countries, may herself become the centre from which all the world will be supplied. It is an interesting fact, that at the same time in another branch of this science, M. Tournet has lately demonstrated that the colours of gems, such as the emerald, aqua-marina, amethyst, smoked rock crystal, and others, are due to volatile hydro-carbons, first noticed by Sir David Brewster in clouded topaz, and that they are not derived from metallic oxides, as has been hitherto believed. Another remarkable advance has recently been made by Bunsen and Kirchoff in the application of the coloured rays of the prism to analytical research. We may consider their discoveries as the commencement of a new era in analytical chemistry, from the extraordinary facilities they afford in the qualitative detection of the minutest traces of elementary bodies. The value of the method has been proved by the discovery of the new metals cæsium and rubidium by M. Bunsen, and it has yielded another remarkable result in demonstrating the existence of iron and six other known metals, in the sun. In noticing the more recent discoveries in this important science, I must not pass over in silence the valuable light which chemistry has thrown upon the composition of iron and steel. Although Despretz demonstrated many years ago that iron would combine with nitrogen, yet it was not until 1857 that Mr. C. Binks proved that nitrogen is an essential element of steel, and more recently M. Carou and M. Fremy have further elucidated this subject; the former showing that cyanogen, or cyanide of ammonium, is the essential element which converts wrought iron into steel; the latter combining iron with nitrogen through the medium of ammonia, and then converting it into steel by bringing it at the proper temperature into contact with common coal gas. There is little doubt that in a few years these discoveries will enable Sheffield manufacturers to replace their present uncertain, cumbrous, and expensive process, by a method at once simple and inexpensive, and so completely under control as to admit of any required degree of conversion being obtained with abselue certainty. Mr. Crace Calvert also has proved that cast iron contains nitrogen, and has shown that it is a definite compound of carbon and iron mixed with various proportions of metallic iron, according to its nature. Before leaving chemical science, I must refer to the interesting discovery by M. Deville, by which he succeeded in rapidly melting 38 or 40 pounds of platinum—a metal till then considered almost infusible. This discovery will render the extraction of platinum from the ore more perfect, and, by reducing its cost, will greatly facilitate its application to the arts.

It is little more than half a century since geology assumed the distinctive character of a science. Taking into consideration the aspects of nature in different epochs of the history of the earth, it has been found that the study of the changes at present going on in the world around us enable us to understand the past revolutions of the globe, and the conditions and circumstances under which strata have been formed and organic remains embedded and preserved. The geologist has increasingly tended to believe that the changes which have taken place on the face of the globe, from the earliest times to the present, are the result of agencies still at work. But whilst it is his high office to record the distribution of life in past ages and the evidence of physical changes in the arrangement of land and water, his results have hitherto indicated no traces of its beginning, nor have they afforded evidence of the time of its future duration. Geology has been indebted for this progress very largely to the investigations of Sedgewick and the writings of Sir Charles Lyell. As an example of the application of geology to the practical uses of life, I may cite the discovery of the gold fields of Australia, which might long have remained hidden but for the researches of Sir Roderick Murchison in the Ural Mountains on the geological position of the strata from which the Russian gold is obtained. From this investigation he was led by inductive reasoning to believe that gold would be found in similar rocks, specimens of which had been sent him from Australia. The last years of the active life of this distinguished geologist have been devoted to the re-examination of the rocks of his native Highlands of Scotland. Applying to them those principles of classification which he long since established, he has demonstrated that the crystaline limestone and quartz rocks which are associated wich micha schists, &c. belong by their embedded organic remains to the lower silurian rocks. Descending from this well-marked horizon he shows the existence beneath all such fossiliferous strata of vast masses of sandstone and conglomerate of Cambrian age; and, lastly, he has proved the existence of a fundamental gneiss, on which all the other rocks repose, and which, occupying the north-western Hebrides and the west coasts of Sutherland and Ross, is the oldest rock formation on the British Isles, it being unknown in England, Wales, or Ireland. It is well known that the temperature increases as we descend through the earth's crust, from a certain point near the surface, at which the temperature is constant. In various mines, borings, and Artesian wells, the temperature has been found to increase about 1° Fahrenheit for every sixty or sixty-five feet of descent. In some carefully-conducted experiments during the sinking, of Dukinfield Deep Mine—one of the deepest pits in this country—it was found that a mean increase of about 1° in seventy-one feet occurred. If we take the ratio thus indicated, and assume it to extend to much greater depths, we should reach, at two and a-half miles from the surface, strata at the temperature of boiling water; and at depths of about fifty or sixty miles the temperature would be sufficient to melt, under the ordinary pressure of the atmosphere, the hardest rocks. Reasoning from these facts, it would appear that the mass of the globe, at no great depth, must be in a fluid state. But this deduction requires to be modified by other considerations, namely—the influence of pressure on the fusing point, and the relative conductivity of the rocks which form the earth's crust. To solve these questions a series of important experiments were instituted by Mr. Hopkins, in the pro-

section of which Dr. Joule and myself took part; and, after a long and laborious investigation, it was found that the temperature of fluidity increased about 1° Fahrenheit for every 500lb. of pressure, in the case of spermaceti, beeswax, and other similar substances. However, on extending these experiments to less compressible substances, such as tin and barytes, a similar increase was not observed. But this series of experiments has been unavoidably interrupted; nor is the series on the conductivity of rocks entirely finished. Until they have been completed by Mr. Hopkins, we can only make a partial use of them in forming an opinion of the thickness of the earth's solid crust. Judging, however, alone from the greater conductivity of the igneous rocks, we may calculate that the thickness cannot possibly be less than nearly three times as great as that calculated in the usual suppositions of the conductive power of the terrestrial mass at enormous depths being no greater than that of the superficial sedimentary beds. Other modes of investigation which Mr. Hopkins has brought to bear on this question appear to lead to the conclusion that the thickness of the earth's crust is much greater even than that above stated. This would require us to assume that a part of the heat in the crust is due to superficial and external rather than central causes. This does not bear directly against the doctrine of central heat, but shows that only a part of the increase of temperature observed in mines and deep wells is due to the outward flow of that heat.

Touching those highly interesting branches of science, botany and zoology, it may be considered presumptuous in me to offer any remarks. I have, however, not entirely neglected in my earlier days to inform myself of certain portions of natural history, which cannot but be attractive to all who delight in the wonderful beauties of natural objects. How interesting is the organisation of animals and plants: how admirably adapted to their different functions and spheres of life. They want nothing, yet have nothing superfluous. Every organ is adapted perfectly to its functions; and the researches of Owen, Agassiz, Darwin, Hooker, Daubeny, Babington, and Jardine fully illustrate the perfection of the animal and vegetable economy of nature.

Two other important branches of scientific research, geography and ethnology, have for some years been united, in this Association, in one section, and that probably the most attractive and popular of them all. We are much indebted to Sir Roderick Murchison, among other members of the Association, for its continued prosperity, and the high position it has attained in public estimation. The spirit of enterprise, courage, and perseverance displayed by our travellers in all parts of the world have been powerfully stimulated and well supported by the Geographical Society, and the prominence and rapid publicity given to discoveries by that body have largely promoted geographical research.

In physical geography the late Baron von Humboldt has been one of the largest contributors, and we are chiefly indebted to his personal researches and numerous writings for the elevated position it now holds among the sciences. To Humboldt we owe our knowledge of the physical features of Central and Southern America. To Parry, Sir James Ross, and Scoresby we are indebted for discoveries in the Arctic and Antarctic regions. Geography has also been advanced by the first voyage of Franklin down the Copper Mine River, and along the inhospitable shores of the Northern Seas, as far as Point Turn Again; as also by that ill-fated expedition in search of a north-west passage; followed by others in search of the unfortunate men who perished in their attempt to reach those ice-bound regions, so often stimulated by the untiring energy of a high-minded woman. In addition to these, the discoveries of Dr. Livingstone in Africa have opened to us a wide field of future enterprise along the banks of the Zambesi and its tributaries. To these we may add the explorations of Captain Burton in the same continent, and those also by Captain Speke and Captain Grant, of a hitherto unknown region, in which it has been suggested that the White Nile has its source, flowing from one of two immense lakes, upwards of 300 miles long by 100 broad, and situated at an elevation of 4,000 feet above the sea. To these remarkable discoveries I ought to add an honourable mention of the sagacious and perilous exploration of Central and Northern Australia by Mr. M'Douall Stuart.

Having glanced, however imperfectly, at some of the most important branches of science which engage the attention of members of this Association, I would now invite attention to the mechanical sciences, with which I am more familiarly acquainted. They may be divided into theoretical mechanics and dynamics, comprising the conditions of equilibrium and the laws of motion; and applied mechanics, relating to the construction of machines. I have already observed that practice and theory are twin sisters, and must work together to ensure a steady progress in mechanical art. Let us then maintain this union as the best and safest basis of national progress, and, moreover, let us recognise it as one of the distinctive aims of the annual reunions of this Association.

During the last century, the science of applied mechanics has made strides which astonish us by their magnitude; but even these, it may reasonably be hoped, are but the promise of future and more wonderful enlargements. I therefore propose to offer a succinct history of these improvements, as an instance of the influence of scientific progress on the well-being of society. I shall take in review the three chief aids which engineering science has afforded to national progress—namely, canals, steam navigation, and railways; each of which has promoted an incalculable extension of the industrial resources of the country.

One hundred years ago the only means for the conveyance of inland merchandise were the packhorses and waggons on the then imperfect highways. It was reserved for Brindley, Smeaton, and others, to introduce a system of canals, which opened up facilities for an interchange of commodities at a cheap rate over almost every part of the country. The impetus given to industrial operations by this new system of conveyance induced capitalists to embark in trade, in mining, and in the extension of manufactures in almost every district. These improvements continued for a series of years, until the whole country was intersected by canals requisite to meet the demands of a greatly extended industry. But canals, however well adapted for the transport of minerals and merchandise, were less suited for the conveyance of passengers. The speed of the canal boats seldom exceeded from two and a half to three miles an hour; and, in addition to this, the projectors of canals sometimes sought to take an unfair advantage of the Act of Parliament which fixed the tariff at so much per ton per mile, by adopting circuitous routes, under the erroneous impression that mileage was a consideration of great importance in the success of such undertakings. It is in consequence of short-sighted views and imperfect legislation that we inherit the numerous curves and distortions of our canal system. These defects in construction rendered canals almost useless for the conveyance of passengers, and led to the improvement of the common roads and the system of stage coaches; so that, before the year 1830, the chief public highways of the country had attained a remarkable smoothness and perfection, and the lightness of our carriages, and the celerity with which they were driven, still excites the admiration of those who remember them. These days of an efficiently worked system, which tasked the power and speed of the horse to the utmost, have now been succeeded by changes more wonderful than any that previously occurred in the history of the human race. Scarcely had the canal system been fully developed when a new means of propulsion was adopted—namely, steam. I need not recount to you the enterprise, skill, and labour that have been exerted in connection with steam navigation. You have seen its results on every river and every sea; results we owe to the fruitful minds of Miller, Symington, Fulton, and Henry Bell, who were the pioneers in the great march of progress. Viewing the past, with a knowledge of the

present and a prospect of the future, it is difficult to estimate sufficiently the benefits that have been conferred by this application of mechanical science to the purposes of navigation. Power, speed, and certainty of action, have been attained on the most gigantic scale. The celerity with which a modern steamer, with a thousand tons of merchandise and some hundreds of human beings on board, cleaves the water and pursues her course, far surpasses the most sanguine expectations of a quarter of a century ago, and indeed almost rivals the speed of the locomotive itself. Previous to 1812, our intercourse with foreign countries and with our colonial possessions depended entirely upon the state of the weather. It was only in favourable seasons that a passage was open, and we had often to wait days, or even a week, before Dublin could be reached from Holyhead. Now, this distance of 63 miles is accomplished in all weathers in little more than three hours. The passage to America used to occupy six weeks or two months; now it is accomplished in eight or nine days. The passage round the Cape to India is reduced from nearly half a year to less than a third of that time, whilst that country may be reached by the overland route in less than a month. These are a few of the benefits derived from steam navigation, and, as it is yet far from perfect, we may reasonably calculate on still greater advantages in our intercourse with distant nations. I will not here enter upon the subject of the numerous improvements which have so rapidly advanced the progress of this important service. Suffice it to observe that the paddle-wheel system of propulsion has maintained its superiority over every other method yet adopted for the attainment of speed, as by it the best results are obtained with the least expenditure of power. In ships of war the screw is indispensable, on account of the security it affords to the engines and machinery, from their position in the hold below the water line, and because of the facility it offers in the use of sails when the screw is raised from its position in the well to a recess in the stern prepared for that purpose. It is also preferable in ships which require auxiliary power in calms and adverse winds, so as to expedite the voyage and effect a considerable saving upon the freight.

The public mind had scarcely recovered itself from the changes which steam navigation had caused, and the impulse it had given to commerce, when a new and even more gigantic power of locomotion was inaugurated. Less than a quarter of a century had elapsed since the first steamboats floated on the waters of the Hudson and the Clyde, when the achievements thence resulting were followed by the application of the same agency to the almost superhuman flight of the locomotive and its attendant train. I well remember the competition at Rainhill in 1830, and the incredulity everywhere evinced at the proposal to run locomotives at twenty miles an hour. Neither George Stephenson himself, nor anyone else, had at that time the most distant idea of the capabilities of the railway system. On the contrary, it was generally considered impossible to exceed ten or twelve miles an hour; and our present high velocities, due to high-pressure steam and the tubular system of boilers, have surpassed the most sanguine expectations of engineers. The sagacity of George Stephenson at once seized upon the suggestion of Henry Booth, to employ tubular boilers; and that, united to the blast pipe, previously known, has been the means of effecting all the wonders we now witness in a system that has done more for the development of practical science and the civilisation of man than any discovery since the days of Adam.

From a consideration of the changes which have been effected in the means for the interchange of commodities I pass on to examine the progress which has been made in their production. And as the steam engine has been the basis of all our modern manufacturing industry, I shall glance at the steps by which it has been perfected.

Passing over the somewhat mythical fame of the Marquis of Worcester, and the labours of Savery, Beighton, and Newcomen, we come at once to discuss the state of mechanical art at the time when James Watt brought his gigantic powers to the improvement of the steam engine. At that time the tools were of the rudest construction, nearly everything being done by hand, and, in consequence, wood was much more extensively employed than iron. Under these circumstances Watt invented separate condensation, rendered the engine double acting, and converted its rectilinear motion into a circular one suitable for the purposes of manufacture. But the discovery at first made little way, the public did not understand it, and a series of years elapsed before the difficulties, commercial and mechanical, which opposed its application, could be overcome. When the certainty of success had been demonstrated, Watt was harassed by infringements of his patent, and lawsuits for the maintenance of his rights. Inventors and pretended inventors set up claims, and entered into combination with manufacturers, miners, and others, to destroy the patent and deprive him of the just fruits of his labour and genius. Such is the selfish heartlessness of mankind in dealing with discoveries not their own, but from which they expect to derive benefit. The steam engine, since it was introduced by Watt, has changed our habits in almost every condition of life. Things which were luxuries have become necessaries, and it has given to the poor man, in all countries in which it exists, a degree of comfort and independence, and a participation in intellectual culture unknown before its introduction. It has increased our manufactures tenfold, and has lessened the barriers which time and space interpose. It ploughs the land, and winnows and grinds the corn. It spins and weaves our textile fabrics. In mining, it pumps, winds, and crushes the ores. It performs these things with powers so great and so energetic as to astonish us at their immensity, whilst they are at the same time perfectly docile, and completely under human control. In war it furnishes the means of aggression, as in peace it affords the bonds of conciliation; and, in fact, places within reach a power which, properly applied, produces harmony and good-will among men, and leads to the happiest results in every condition of human existence. We may, therefore, well be proud of the honour conferred on this country as the cradle of its origin, and as having fostered its development from its earliest applications to its present high state of perfection. I cannot conclude this notice of the steam engine without observing the changes it is destined to effect in the cultivation of the soil. It is but a short time since it was thought inapplicable to agricultural purposes, from its great weight and expense. But more recent experience has proved this to be a mistake, and already in most districts we find that it has been pressed into the service of the farm. The small locomotive, mounted on a frame with four wheels, travels from village to village with its attendant, the threshing machine, performing the operations of threshing, winnowing, and cleaning, at less than one half the cost by the old and tedious process of hand labour. Its application to ploughing and tillage on a large scale is, in my opinion, still in its infancy, and I doubt not that many members of this Association will live to see the steam plough in operation over the whole length and breadth of the land. Much has to be done before this important change can be successfully accomplished; but, with the aid of the agriculturist preparing the land so as to meet the requirements of steam machinery, we may reasonably look forward to a new era in the cultivation of the soil.

The extraordinary developments of practical science in our system of textile manufacture are, however, not entirely due to the steam engine, although they are now in a great measure dependent on it. The machinery of these manufactures had its origin before the steam engine had been applied, except for mining purposes; and the inventions of Arkwright, Hargreaves, and Crompton, were not conceived under the impression that steam would be their moving power. On the contrary, they depended upon water; and

the cotton machinery of this district had attained considerable perfection before steam came to the aid of the manufacturer, and ultimately enabled him to increase the production to its present enormous extent. I shall not attempt a description of the machinery of the textile manufactures, because ocular inspection will be far more acceptable. I can only refer you to a list of establishments in which you may examine their operations on a large scale, and which I earnestly recommend to your attention. I may, however, advert to a few of the improvements which have marked the progress of the manufacturing system in this country. When Arkwright patented his water frames in 1767, the annual consumption of cotton was about four million pounds weight. Now it is one thousand two hundred million pounds weight—three hundred times as much. Within half a century the number of spindles at work, spinning cotton alone, has increased tenfold; whilst, by superior mechanism, each spindle produces fifty per cent more yarn than on the old system. Hence the importance to which the cotton trade has risen, equalling at the present time the whole revenue of the three kingdoms, or £70,000,000 sterling per annum. As late as 1820 the power loom was not in existence, now it produces about fourteen million yards of cloth, or, in more familiar terms, nearly eight thousand miles of cloth per diem. I give these particulars to show the immense power of production of this country, and to afford some conception of the number and quality of the machines which effect such wonderful results. Mule spinning was introduced by Crompton, in 1787, with about twenty spindles to each machine. The powers of the machine were, however, rapidly increased; and now it has been so perfected that 2,000, or even 3,000 spindles are directed by a single person. At first the winding on, or forming the shape of the cop, was performed by hand; but this has been superseded by rendering the machine automatic, so that it now performs the whole operation of drawing, stretching, and twisting the thread, and winding it on to the exact form, ready for the reel or shuttle as may be required. These, and other improvements in carding, roving, combing, spinning, and weaving, have established in this country an entirely new system of industry; it has given employment to greatly increased numbers, and a more intelligent class of workpeople.

Similarly important improvements have been applied to the machinery employed in the manufacture of silk, flax, and wool; and we have only to watch the processes in these different departments to be convinced that they owe much to the development of the cotton manufacture. In the manufacture of worsted, the spinning jenny was not employed at Bradford until 1790, nor the power loom until about 1825. The production of fancy or mixed goods from alpaca and mohair wool, introduced to this country in 1836, is perhaps the most striking example of a new creation in the art of manufacture, and is chiefly due to Mr. Titus Salt, in whose immense palace of industry, at Saltaire, it may be seen in the greatest perfection. In flax machinery, the late Sir Peter Fairbairn was one of the most successful inventors, and his improvements have contributed to the rapid extension of this manufacture.

I might greatly extend this description of our manufacturing industry, but I must for the present be brief, in order to point out the dependence of all these improvements on the iron and coal so widely distributed amongst the mineral treasures of our island. We are highly favoured in the abundance of these minerals, deposited with an unsparing hand by the great Author of Nature under so slight a covering as to bring them within the reach of the miner's art. To them we owe our present high state of perfection in the useful arts; and to their extended application we may safely attribute our national progress and wealth. So that, looking to the many blessings which we daily and hourly receive from these sources alone, we are impressed with devotional feelings of gratitude to the Almighty for the manifold bounties He has bestowed upon us.

Previously to the inventions of Henry Cort, the manufacture of wrought iron was of the most crude and primitive description. A hearth and a pair of bellows was all that was employed. But, since the introduction of puddling, the ironmasters have increased the production to an extraordinary extent, down to the present time, when processes for the direct conversion of wrought iron on a large scale are being attempted. A consecutive series of chemical researches into the different processes, from the calcining of the ore to the production of the bar, carried on by Dr. Percy and others, has led to a revolution in the manufacture of iron; and although it is at the present moment in a state of transition, it nevertheless requires no very great discernment to perceive that steel and iron of any required tenacity will be made in the same furnace, with a facility and certainty never before attained. This has been effected, to some extent, by improvements in puddling; but the process of Mr. Bessemer — first made known at the meeting of this Association at Cheltenham—affords the highest promise of certainty and perfection in the operation of converting the melted pig direct into steel or iron, and is likely to lead to the most important developments in this manufacture. These improvements in the production of the material must, in their turn, stimulate its application on a larger scale and lead to new constructions.

In iron-ship building, an immense field is opening before us. Our wooden walls have, to all appearance, seen their last days; and, as one of the early pioneers in iron construction, as applied to shipbuilding, I am highly gratified to witness a change of opinion that augurs well for the security of the liberties of the country. From the commencement of iron-ship building in 1830 to the present time, there could be only one opinion amongst those best acquainted with the subject, namely, that iron must eventually supersede timber in every form of naval construction. The large ocean steamers, the Himalaya, the Persia, and the Great Eastern, abundantly show what can be done with iron, and we have only to look at the new system of casing ships with armour plates, to be convinced that we can no longer build wooden vessels of war with safety to our naval superiority and the best interests of the country. I give no opinion as to the details of the re-construction of the navy,—that is reserved for another place,—but I may state that I am fully persuaded that the whole of our ships of war must be re-built of iron, and defended with iron armour calculated to resist projectiles of the heaviest description at high velocities. In the early stages of iron-ship building, I believe I was the first to show, by a long series of experiments, the superiority of wrought iron over every other description of material in security and strength, when judiciously applied in the construction of ships of every class. Other considerations, however, affect the question of vessels of war; and although numerous experiments were made, yet none of the targets were on a scale sufficient to resist more than a six-pounder shot. It was reserved for our scientific neighbours, the French, to introduce thick iron plates as a defensive armour for ships. The success which has attended the adoption of this new system of defence affords the prospect of invulnerable ships of war, and hence the desire of the Government to re-model the navy on an entirely new principle of construction, in order that we may retain its superiority as the great bulwarks of the nation. A committee has been appointed by the War Office and the Admiralty for the purpose of carrying out a scientific investigation of the subject, so as to determine,—first, the best description of material to resist projectiles; secondly, the best method of fastening and applying that material to the sides of ships and land fortifications; and lastly, the thickness necessary to resist the different descriptions of ordnance. It is asserted, probably with truth, that whatever thickness of plates are adopted for casing ships, guns will be constructed capable of destroying them. But their destruction will even then be a work of time, and I believe, from what I have seen in recent experiments, that with proper armour it will require, not only the most powerful ordnance, but also a great concentration of fire, before

fracture will ensue. If this be the case, a well-constructed iron ship, covered with sound plates of the proper thickness, firmly attached to its sides, will, for a considerable time, resist the heaviest guns which can be brought to bear against it, and be practically shot-proof. But our present means are inadequate for the production of large masses of iron, and we may trust that, with new tools and machinery, and the skill, energy, and perseverance of our manufacturers, every difficulty will be overcome, and armour plates produced which will resist the heaviest existing ordnance.

The rifling of heavy ordnance, the introduction of wrought iron, and the new principle of construction with strained hoops, have given to all countries the means of increasing enormously the destructive power of their ordnance. One of the results of this introduction of wrought iron, and correct principles of manufacture, is the reduction of the weight of the new guns to about two-thirds the weight of the older cast-iron ordnance. Hence follows the facility with which guns of much greater power can be worked, whilst the range and precision of fire are at the same time increased. But these improvements cannot be confined to ourselves. Other nat ons are increasing the power and range of their artillery in a similar degree, and the energies of the nation must, therefore, be directed to maintain the superiority of our navy in armour as well as in armament.

We have already seen a new era in the history of the construction of bridges, resulting from the use of iron; and we have only to examine those of the tubular form over the Conway and Menai Straits to be convinced of the durability, strength, and lightness of tubular constructions applied to the support of railways or common. roads, in spans which, ten years ago, were considered beyond the reach of human skill. When it is considered that stone bridges do not exceed 150 feet in span, nor cast-iron bridges 250 feet, we can estimate the progress which has been made in crossing rivers 400 or 500 feet in width, without any support at the middle of the stream. Even spans, greatly in excess of this, may be bridged over with safety, provided we do not exceed 1,800 to 2,000 feet, when the structure would be destroyed by its own weight.

It is to the exactitude and accuracy of our machine tools that our machinery of the present time owes its smoothness of motion and certainty of action. When I first entered this city, the whole of the machinery was executed by hand. There were neither planing, slotting, nor shaping machines; and, with the exception of very imperfect lathes and a few drills, the preparatory operations of construction were effected entirely by the hands of the workmen. Now everything is done by machine tools, with a degree of accuracy which the unaided hand could never accomplish. The automaton, or self-acting machine tool, has, within itself, almost a creative power; in fact, so great are its powers of adaptation, that there is no operation of the human hand that it does not imitate. For many of these improvements the country is indebted to the genius of our townsmen, Mr. Richard Roberts and Mr. Joseph Whitworth. The importance of these constructive machines is, moreover, strikingly exemplified in the Government works at Woolwich and Enfield Lock, chiefly arranged under the direction of Mr. Anderson, the present inspector of machinery, to whose skill and ingenuity the country is greatly indebted for the efficient state of those great arsenals.

Amongst the changes which have largely contributed to the comfort and enjoyment of life, are the improvements in the sanitary condition of towns. These belong, probably, to the province of social rather than mechanical science; but I cannot omit to notice some of the great works that have of late years been constructed for the supply of water, and for the drainage of towns. In former days, 10 gallons of water to each person per day was considered an ample allowance. Now 30 gallons is much nearer the rate of consumption. I may instance the waterworks of this city and of Liverpool, each of which yield a supply of from 20 to 30 gallons of water to each inhabitant. In the former case the water is collected from the Cheshire and Derbyshire hills, and, after being conveyed in tunnels and aqueducts a distance of ten miles to a reservoir, where it is strained and purified, it is ultimately taken a further distance of eight miles in pipes, in a perfectly pure state, ready for distribution. The greatest undertaking of this kind, however, yet accomplished, is that by which the pure waters of Loch Katrine are distributed to the city of Glasgow. This work recently completed by Mr. Bateman, who was also the constructor of the waterworks of this city, is of the most gigantic character, the water being conveyed in a covered tunnel a distance of 27 miles, through an almost impassable country, to the service reservoir, about eight miles from Glasgow. By this means 40,000,000 gallons of water per day are conveyed through the hills which flank Ben Lomond, and after traversing the sides of Loch Chon and Loch Aird, are finally discharged into the Mugdock basin, where the water is impounded for distribution. We may reasonably look forward to an extension of similar benefits to the Metropolis, by the same engineer, whose energies are now directed to an examination of the pure fountains of Wales, from whence the future supply of water to the great city is likely to be derived. A work of so gigantic a character may be looked upon as problematical, but when it is known that six or seven millions of money would be sufficient for its execution, I can see no reason why an undertaking of so much consequence to the health of London should not ultimately be accomplished.

In leaving this subject, I cannot refrain from an expression of deep regret at the loss which science has sustained through the death of one of our vice presidents, the late Professor Hodgkinson. For a long series of years he and I worked together in the same field of scientific research, and our labours are recorded in the Transactions of this and other Associations. To Mr. Hodgkinson we owe the determination of the true form of cast-iron beams, or section of greatest strength; the law of the elasticity of iron under tensile and compressive forces; and the laws of resistance of columns to compression. I look back to the days of our joint labour with unalloyed pleasure and satisfaction. I regret to say that another of our vice presidents, my friend Mr. Joseph Whitworth, is unable to be present with us through serious, but I hope not dangerous, illness. To Mr. Whitworth, mechanical science is indebted for some of the most accurate and delicate pieces of mechanism ever executed; and the exactitude he has introduced into every mechanical operation will long continue to be the admiration of posterity. His system of screw threads and gauges is now in general use throughout Europe. We owe to him a machine for measuring with accuracy to the millionth of an inch, employed in the production of standard gauges; and his laborious and interesting experiments on rifled ordnance have resulted in the production of a rifled small arm and gun which have never been surpassed for range and precision of fire. It is with pain that I have to refer to the cause which deprives me of his presence and support at this meeting.

A brief allusion must be made to that marvellous discovery which has given to the present generation the power to turn the spark of heaven to the uses of speech; to transmit along the slender wire for a thousand miles a current of electricity that renders intelligible words and thoughts. This wonderful discovery, so familiar to us, and so useful in our communications to every part of the globe, we owe to Wheatstone, Thomson, De la Rive, and others. In land telegraphy the chief difficulties have been surmounted, but in submarine telegraphy much remains to be accomplished. Failures have been repeated so often as to call for a Commission on the part of the Government to inquire into the causes, and the best means of overcoming the difficulties which present themselves. I had the honour to serve on that Commission; and I believe that from the report, and mass of evidence and experimental research accumulated, the public will derive very important information. It is well known that three conditions are essential to success in the con-

struction of ocean telegraphs—perfect insulation, external protection, and appropriate apparatus for laying the cable safely on its ocean bed. That we are far from having succeeded in fulfilling these conditions is evident from the fact that out of twelve thousand miles of submarine cable which have been laid since 1851, only three thousand miles are actually in working order; so that three fourths may be considered as a failure and loss to the country. The insulators hitherto employed are subject to deterioration from mechanical violence, from chemical decomposition or decay, and from the absorption of water; but the last circumstance does not appear to influence seriously the durability of cables. Electrically, indiarubber possesses high advantages, and, next to it, Wray's compound and pure gutta percha far surpass the commercial gutta percha hitherto employed; but it remains to be seen whether the mechanical and commercial difficulties in the employment of these new materials can be successfully overcome. The external protecting covering is still a subject of anxious consideration. The objections to iron wire are its weight and liability to corrosion. Hemp has been substituted, but at present with no satisfactory result. All these difficulties, together with those connected with the coiling and paying out of the cable, will no doubt yield to careful experiment and the employment of proper instruments in its construction and its final deposit on the bed of the ocean. Irrespective of inland and international telegraphy, a new system of communication has been introduced by Professor Wheatstone, whereby intercourse can be carried on between private families, public offices, and the works of merchants and manufacturers. This application of electric currents cannot be too highly appreciated, from its great efficiency and comparatively small expense. To show to what an extent this improvement has been carried, I may state that one thousand wires, in a perfect state of insulation, may be formed into a rope not exceeding half an inch in diameter.

I must not sit down without directing attention to a subject of deep importance to all classes, namely, the amount of protection inventors should receive from the laws of the country. It is the opinion of many that patent laws are injurious rather than beneficial, and that no legal protection of this kind ought to be granted; in fact, that a free trade in inventions, as in everything else, should be established. I confess I am not of that opinion. Doubtless there are abuses in the working of the patent law as it at present exists, and protection is often granted to pirates and impostors, to the detriment of real inventors. This, however, does not contravene the principle of protection, but rather calls for reform and amendment. It is asserted by those who have done the least to benefit their country by inventions, that a monopoly is injurious, and that if the patent laws are defended, it should be, not on the ground of their benefit to the inventor, but on that of their utility to the nation. I believe this to be a dangerous doctrine, and I hope it will never be acted upon. I cannot see the right of the nation to appropriate the labours of a lifetime, without awarding any remuneration. The nation, in this case, receives a benefit; and assuredly the labourer is worthy of his hire. I am no friend of monopoly, but neither am I a friend of injustice; and I think that before the public are benefitted by an invention, the inventor should be rewarded either by a fourteen years' monopoly, or in some other way. Our patent laws are defective, so far as they protect pretended inventions; but they are essential to the best interests of the state in stimulating the exertions of a class of eminent men, such as Arkwright, Watt, and Crompton, whose inventions have entailed upon all countries invaluable benefits, and have done honour to the human race. To this Association is committed the task of correcting the abuses of the present system, and establishing such legal provisions as shall deal out equal justice to the inventor and the nation at large. I must not forget that we owe very much to an entirely new and most attractive method of diffusing knowledge, admirably exemplified in the Great Exhibition of 1851, and its successors in France, Ireland, and America. Most of us remember the gems of art which were accumulated in this city during the summer of 1857, and the wonderful results they produced on all classes of the community. The improvement of taste, and the increase of practical knowledge which followed these exhibitions, has been deeply felt; and hence the prospects which are now opening before us in regard to the Exhibition of the next year cannot be too highly appreciated. That Exhibition will embrace the whole circle of the sciences, and is likely to elevate the general culture of the public to a higher standard than we have ever before attained. There will be unfolded almost every known production of art, every ingenious contrivance in machinery, and the results of discoveries in science from the earliest period. The fine arts, which constituted no part of the Exhibition of 1851, and which were only partially represented at Paris and Dublin, will be illustrated by new creations from the most distinguished masters of the modern school. Looking forwards, I venture to hope for a great success and a further development of the principle advocated by this Association, the union of science and art.

In conclusion, my apologies are due to you for the length of this address, and I thank you sincerely for the patient attention with which you have listened to the remarks I have had the honour to lay before you. As the President of the British Association, I feel that far beyond the consideration of merely personal qualifications, my election was intended as a compliment to practical science, and to this great and influential metropolis of manufacture, where those who cultivate the theory of science may witness, on its grandest scale, its application to the industrial arts. As a citizen of Manchester, I venture to assure the Association that its intentions are appreciated; and to its members, as well as to the strangers who have been attracted here by this meeting, I offer a most cordial welcome.

Lord STANLEY then rose, and was greeted with cheering. The noble Lord said:—Ladies and gentlemen,—I am afraid that it will altogether be out of my power to make myself audible to more than a small portion of that vast audience which I am attempting to address. I have been asked to propose a resolution, and I do so with great pleasure.—(Cheers.) I have come here like the great majority of those to whom I am speaking, as a learner, and not as a teacher—as a pupil, and not as a master; and therefore my remarks will be exceedingly brief. I believe we are all agreed in our wish to pay due honour to those eminent men of science who have met in Manchester on this interesting occasion.—(Cheers.) You are always ready in Manchester to pay a due tribute of respect to intellectual eminence in any profession; and scientific men—I may speak of them freely, for I am not one myself—have upon you this especial claim, that while their works are comparatively less before the public eye than those of men who pursue other professions, the results of that work endure for ever.—(Cheers.) Great conquerors, great statesmen, great authors, have their day of influence and popularity; but that influence and that popularity pass away, and even their names are but faintly remembered. But every victory which is won in the field of physical discovery—every conquest of man over nature—however slight it may seem to be, however slowly and gradually it may be effected, is effected not for a single nation nor for a single age, but for all countries and for all time.—(Applause.) Lancashire has contributed her full share to the long list of English cultivators of science. There are many names which will occur to every one here—the name of the illustrious Dalton, the name of Dr. Whewell, one of the first mathematicians of the day; and the name of Professor Owen, whom we have fortunately present amongst us.—(Applause.) There are others hardly less illustrious, who if time and opportunity served I might enumerate here. But I will pass from that topic, and will only say this—that I believe there is no city and no district in the country which has profited more by the prac-

tical application of science than this city of Manchester, and the district of which it is the centre.—(Applause.) What is it that has made this great metropolis of manufacturing industry what it is? It is not manual labour; that we have everywhere. It is not the abundance of capital; for capital goes wherever it can find an investment. It is not even the coal under our feet, or the water which feeds our steam engines; nor is it our proximity to the sea. Though all these are great, and some of them indispensable advantages, still they may be found in other localities less distinguished. What I believe has made us a race of practical workers, is the inventive aptitude and the peculiar and the almost exclusive devotion which has been shown here to the practical application of scientific methods and processes to supply the material wants of mankind.—(Applause.) It is here, therefore, above all other places, that the workers—and when I say workers there are workers in all classes—that the men of business should pay honour to the men of thought.—(Cheers.) It is here, above all places, that those who have reaped the reward, and have profited by the result, of scientific invention, should be the foremost to acknowledge the merits of those without whose labours scientific inventions could not have taken place.—(Cheers.) But there are other objects of our meeting besides those of paying honour to those who are visiting us here. There are two classes of persons who are in the habit of attending such meetings as ours. There are some who come here as students; who come in the hope—and it is a hope not often disappointed—of gathering from our lectures and our discussions some hints and suggestions which they may afterwards have an opportunity of working out in the only way in which scientific ideas can be worked out—in retirement, and at leisure. There is another class of persons, not hitherto devoted to science, who come here partly from the instigation of a natural curiosity, and a desire to meet the leading men of our time; who come here to catch from the impulse of a popular enthusiasm that taste for experimental research, and for scientific investigation, which is often latent in many a man's mind, but of which he is not aware that it is there until circumstances call it out. For both, our meetings are designed; and I think that neither will be disappointed. If they are—if these meetings are barren of results—I think the fault will be our own: and I hope, nay I confidently believe and expect, that there will be many men who will look back hereafter with pleasure to what has passed here, and will be able to say that here was first sown the seed which afterwards germinated in their minds, and which they have known how to render practically available, not only for their own advantage, but for the advantage of their neighbours, their country, and all mankind.—(Applause.) Ladies and gentlemen, I have said a little more than I meant; but the object for which I rose was to propose a resolution which has been put into my hands, and which I am sure you will all cordially accept. I do not venture to offer any word of criticism upon the address to which you have just listened. This I will say. We all hear Mr. Fairbairn with respect, not only on account of the private character of the man—and he is known to us all—but also because he himself is entitled to take an honourable place amongst the pioneers of scientific research.—(Cheers.) I have to propose, "That the thanks of the members of the Association be voted to the President for his excellent address, and that his permission be asked to allow it to be circulated among the members."—(Loud applause.)

Mr. J. A. Turner, M.P.: I assure you it is not any wish of my own that I should rise to address you, but I do so in obedience to the request of the Committee that I should second the resolution which has been so ably placed before you by my Lord Stanley.—(Hear, hear.) I presume I have been requested to second this resolution because I happen to be one of the representatives of this city; and as Lord Stanley, representing the aristocracy of the county, has expressed his high approval of Mr. Fairbairn's merits, and as he rejoices that the Association has met in this district, so I, identified entirely with commerce, and representing this city, may perhaps be not unfitted to second this resolution—(applause)—and to express my own most cordial feeling of rejoicing, not only that the British Association has honoured Manchester with a visit this year, but still further has honoured Manchester by appointing one of its most distinguished citizens as the president for the year.—(Loud applause.) It is not your wish, nor is it mine, that you should be detained longer this evening; but I cannot help saying that, highly distinguished as William Fairbairn is, amongst us he is valued even more for his private character than for his scientific attainments.—(Cheers.) In a note I received from him some time ago, there is one expression most characteristic of the man. I addressed him as "Dr. Fairbairn," and I believe I put some letters after his name. (Laughter.) He replied, "Pray, in future, address me as an old dissenting minister named me many years ago—William Fairbairn." Learned societies may add letters to that name, may give him the dignity of a doctor, may even make him President of the British Association; but William Fairbairn, the citizen of Manchester, making his own way in the world by his own merit, distinguishing himself on every occasion not only by his talent but by his modesty and unassuming character, will long be remembered in this community as one of its most distinguished ornaments.—(Applause.) He has given to you this night an address which I am afraid very few of you would be able to hear, for in this large hall a man even with strong lungs can scarcely make himself perfectly heard; but you will have this address printed and circulated amongst the members, for that is the object of the motion proposed by Lord Stanley, and which I have the greatest pleasure in seconding.—(Applause.)

The Mayor of Manchester (M Curtis, Esq.) said it was not the least of the pleasures attached to the office he now held, to be privileged to put this resolution to the meeting. He called upon them to vote upon it and to adopt it with acclamation.—The resolution was then carried amidst hearty applause.

The President, in reply, said he felt deeply indebted to the noble Lord and to Mr. Turner for the very flattering way in which they had brought his name before the meeting. He could only state this, that during the time he had the honour to preside in that chair, it should be his endeavour on every occasion not only to promote the advancement of science, but to do everything to honour the science of Manchester and its citizens.—(Cheers.)

Professor Phillips, after announcing that programmes of each day's proceedings could be obtained every morning after eight o'clock at the Portico, in Mosley-street, stated that on Monday evening the number of tickets sold was 684; on Tuesday evening, the number had increased to 1,394; and up to one o'clock on the present day he found that a total of 1,919 tickets had been disposed of. They had received that evening, at eight o'clock, old life members, who no longer paid to the society, 229; new life members, 76, who had paid £760; old annual members, who had come back to them, 140; new annual members entered, 83, contributing £166. 656 ladies' tickets had been purchased, and the number of associates or members for the present year was 1,194. They had, therefore, up to eight o'clock, 2,388 members, and had received £2,916 to be entirely devoted to the advancement of science.—(Applause.) Since 1838, except when the Prince Consort presided at the meeting at Aberdeen, they had never had so large a register on the opening day of the meeting. He was proud to see that as many persons had come to do honour to William Fairbairn as to the Prince Consort.—(Loud cheers.)

The proceedings of the evening were then closed.

THURSDAY, SEPT. 5.

The proceedings of the eight sections of the Association commenced this morning. There was consequently a great demand at the reception-room, in the Portico Mosley-street, for copies of the *Journal* containing the lists of papers proposed to be read, and also for other documents. This, added to the business connected with the issue of tickets, caused the reception-room to be thronged until the afternoon; but everything was transacted speedily and satisfactorily, thanks to the very excellent arrangements made by the local secretaries, and the unceasing exertions of the various officials.

PROCEEDINGS OF THE SECTIONS.

The sectional meetings opened at eleven o'clock, and in every case there was a large attendance of members.

SECTION A. — MATHEMATICAL AND PHYSICAL SCIENCE.

This section assembled in the Gallery of Antique Sculpture, at the Royal Institution.

The PRESIDENT (Professor Airy, astronomer royal) said:—It has been usual, in opening the proceedings of this section, to commence with a few words stating generally the object for which we meet and the way in which we propose to carry it out. The section treats of mathematics and natural philosophy; and in these terms we include everything which is not of a technical nature, and which is subject to mathematical treatment. Everything which is reducible to measures or forces, comes properly under our consideration, so far as it is not expressly a subject for some of the technical sections. Thus the laws of motion, and everything relating to weights and measures are proper subjects for us, provided they are not within the domains of civil engineering. The cosmology of the world, the changes which the surface of the earth has undergone, come fairly before us, so far as they are not provided for in the section of geology. This may indeed be considered as the section which contains upon the whole the germ of all the sciences which are the subjects of measure and of number; and in this respect the subjects which are embraced by the section may be compared with those which in the best of the University systems have formed the foundation for the important Degree of Arts, and which are understood to be the best possible foundation for the education of the human mind, whether as preparing its powers, or furnishing it with knowledge. It was to the subjects of this section that the early efforts of the Association were in a great measure directed; and it is by them also that in a great measure it has acquired its present importance. It is well known to members that, with regard to Astronomy, the earliest efforts of the Association were directed to that subject, almost its earliest expenditure of money being with reference to Astronomy. The works published by the Association, at its own expense, have been amongst the most valuable contributions to that science; and by expenditure in that way the Association acquired a command over the Government, which enabled it to call for the assistance of Government in very important matters relating to the same general class of subjects. Amongst these I may mention the great reduction of the lunar observations at Greenwich, which was undertaken mainly, if not solely, through the urgency of the representations of the Association; and anybody who knows the history of science will know that that great work is one of the most important aids rendered to Astronomy in the present age. There are other subjects of the same kind, and one of them has derived the most powerful aid from the Association—I mean the great magnetic expeditions under Colonel Sabine. These expeditions have made us acquainted with the state of magnetism all over the earth, and have given a foundation for magnetical science, such as could not have been acquired in any other way.—The President, in continuation, invited communications, urging that in all cases it should be remembered that they were treating questions strictly of science, and that, as this section had been in former years generally more pressed from the beginning to the end of the meeting than any other, that time was their most precious commodity. It was desirable that nothing should be brought before the meeting which would not be understood *ipso facto* by the majority of those present. It would be of no use to bring complicated formulæ which could not be understood without a month's study in a printed book; nor was it consistent with the dignity of the Association that any of those questions should be introduced, such as the squaring of the circle and perpetual motion, which had been rejected by the learned in all ages. The PRESIDENT added that at the last meeting Professor Sookes was requested by the Committee of Recommendations, at the instance of this section, to prepare a report "On the present state of Physical Optics." The Professor had written to state that he had been prevented by a great quantity of public business from preparing the report; but he engaged generally, if possible, to prepare it by the next meeting of the Association, and the Committee had requested that he would do so. A similar communication had been received from Mr. Keighley with respect to a report "On the Solution of certain specific Problems in Dynamics;" and he, at the request of the Committee, had engaged to do his best to complete the report for the next meeting.

CELESTIAL PHOTOGRAPHY.

Mr. WARREN DE LA RUE read the following report "On the progress of Celestial Photography since the meeting at Aberdeen."

At the Aberdeen meeting I had the honour of communicating to this section a report on the state of Celestial Photography in England, which has since appeared in the Transactions of the Association. Since that period I have pursued my investigations in this branch of astronomy, and ascertained some facts which I believe will be of interest to the meeting. In the first place, I beg to recall to the recollection of members who may have read my paper, and re-state for the information of those who have not done so, that it was intended, at the period of the Aberdeen meeting, that the Kew photoheliograph should be taken to Spain, in order, if possible, to photograph the luminous prominences, or, as they are usually called, the red flames, seen on the occasion of a total solar eclipse. The words implying a doubt as to the success of the undertaking were advisedly inserted, because so little information could be collected from the accounts of those observers who had witnessed previous total eclipses as to the probable intensity of the light of the corona and red flames in comparison with other luminous bodies. My impression was that I should fail in depicting the prominences in the time available for doing so, because I had had the Kew instrument tried upon the moon, and failed utterly in getting even a trace of her image on the sensitive plate, and the corona and prominences together were supposed not to give as much light as the moon. I therefore pointed out the desirability of other astronomers making attempts to depict the phenomena of totality by projecting the image of the pro-

minences direct on to the collodion plate without enlarging it by a secondary magnifier as in the Kew instrument. It was fair to assume, with the great experience I had acquired in celestial photography, that I should succeed with the Kew instrument if success were attainable, and I knew that far more reliable results would be obtained by this instrument than by the other means I recommended should be employed as the surer means of obtaining some record. Two theories existed, as is well known, to account for the red prominences,—the one prominently supported by the Astronomer Royal was that they belonged to the sun; the other, which is still supported even by an astronomer who obtained photographs of them at the last eclipse, was that they are produced by the deffraction of the sun's light by the periphery of the moon. It will be seen, therefore, how essential it was not only to obtain photographic images of the prominences, but also how important it was to obtain such perfect images of them that they could not be confounded with the purely deffraction phenomena, if such existed, and that the images should be on such a scale that the defects common to collodion could not be confounded with them. The "pretty near" would have been far more readily accomplished, but having the whole bearing of the subject fully impressed on my mind I preferred to make a bold venture, and either accomplish what I aimed at or fail entirely. Fortunately I was successful, and to that success the steadiness of my staff much contributed. We now know that the luminous prominences which surround the sun, for they do belong to him, can be depicted in from twenty to sixty seconds, on the scale of the sun's diameter equal ⅓ of the object glass employed. That is to say, an object glass of three inches aperture will give a picture of the prominences surrounding a moon four inches in diameter. The next subject I have to call your attention to is the photographic depiction of groups of stars, for example, such as form a constellation like Orion—in other words, the mapping down the stars by means of photography. I have made several experiments in this direction, and have obtained satisfactory results, and I believe that, at last, I have hit upon an expedient which will render this method of mapping stars easy of accomplishment. The instrument best adapted for this object is a camera of short focal length in relation to the aperture, like the ordinary portrait lens, the size of lens being selected to suit the scale of the intended photographic map; and the camera of course mounted on equatorial stand, with clock-work motion. The fixed stars depict themselves with great rapidity on a collodion plate, and I have experienced no difficulty in obtaining pictures of the Pleiades by a moderate exposure even in the focus of my telescope, and they would be fixed much more rapidly by a portrait camera. The difficulty in star-mapping does not consist in the difficulty of fixing the images of stars, but in finding the images when they are imprinted, for they are no bigger than the specks common to the best collodion. It is of no service attempting to overcome the difficulty by enlarging the whole picture; but something may be done by causing the images of the stars, which are mere spots, to spread out into a cone of rays by putting the image out of focus, and thus to imprint a disc on the plate instead of a point. Last year has been so fully employed that I have not yet had time to fully develope this method, but I have ascertained its practicability. Some curiosity naturally exists as to the possibility of applying photography to the depiction of those wonderful bodies, the comets, which arrive generally without anything being known of their previous history, and absolutely nothing as to their physical nature. It would be valuable to have photographic records of them, especially of their nucleus and coma, which undergo changes from day to day, and hence such a means of recording their changes as photography offers would be the best beyond comparison, if the light of the comet were sufficiently intense to imprint itself. On the appearance of Donati's comet in 1858, I made some attempts to delineate it with my reflector on a collodion film, but without success; and on the appearance of the comet of the present year, I made numerous attempts, not only with my telescope, but also with a portrait camera, to depict it, but even with an exposure of 15 minutes (minutes, not seconds), I failed in getting the slightest impression, even with the portrait camera. Hence, this conclusion may be arrived at, that the actinic ray does not exist in sufficient intensity in such a comet as the last to imprint itself, and, therefore, photography is inapplicable to the recording of the appearances of these wonderful bodies. I now return to heliography. Experiments conducted at the Kew Observatory, by my request, have shown that for an image of the sun of any given size when once the aperture of the telescope has been ascertained which is sufficient to produce the picture with the necessary degree of rapidity, it is not beneficial to increase that aperture, that is to say, no more details are depicted, nor does the picture become sharper so as to bear a greater subsequent enlargement in copying than when the smaller aperture is used. It has also been ascertained experimentally that it is not well to enlarge the image beyond a certain point, by increasing the magnifying power of the secondary magnifier, so as to cause the rays to emerge at a greater angle. These results are such as I should have anticipated; but as it was nevertheless desirable to produce pictures of the sun's spots, with a view to their closer study, on a scale considerably greater than the pictures produced by the Kew instrument, I commenced some preparations at my own observatory, for trying whether it would be possible to procure such pictures with my reflector. On maturing my plans, I found that the apparatus which it would be necessary to append would be so weighty that the telescope would require to be strengthened considerably, to support the additional weight in the awkward position it had to be placed in, and it did not at first appear how this could be conveniently done. Ultimately, I found the means of adding a radius bar, and of supporting the plate holder which carries a plate 18 inches square, at a distance of four feet from the eye-piece. But here another difficulty occurred, namely, that the image of the sun was so powerfully heating that, if allowed to remain for a very short time on the instantaneous slide, it heated it and ultimately set fire to some part of the apparatus. A trap easy to be moved over the mouth of the telescope had to be contrived so as to open just before the instantaneous apparatus was brought into action, and again shut immediately afterwards. At last these mechanical difficulties were surmounted, and I commenced my experiments to ascertain the best form of secondary magnifier; these experiments are still in progress, and some important difficulties remain to be overcome before pictures of the sun's spots will be obtained with that degree of sharpness which shall leave nothing to desire. With an ordinary Hayghonian eye-piece employed as a secondary magnifier, and placed somewhat nearer the great mirror than its position for the most perfect optical picture, in order to throw the chemical rays further on so as to bring them to focus on the plate, I have obtained some sun pictures of very considerable promise on the extremely large scale of the sun's diameter equal 3ft. These pictures have only been very recently procured, and I submit them to the section because I believe that an interest is felt in the progress of celestial photography, and that our members prefer to take part in the experiments as it were by watching their progress, rather than to wait until the most perfect results have been brought about. I may state the mechanical and chemical difficulties have been surmounted, and the only outstanding one is the form of the secondary magnifier. When this has been worked out, perfect sun pictures three feet in diameter will be obtainable with a telescope of one foot aperture in less than the 20th of a second of time. These pictures, when taken under suitable circumstances, may be grouped so as to produce stereoscopic pictures, which must throw considerable light on the nature of the spots. It appears to me that such results must be of value to science, and that such records of

the state of the sun's photosphere, both as regards spots and other changing phenomena, which are obtainable by means of photography, are worth collecting and discussing. It is agreeable to me to work out the problem, so as to point out the means by which success is attainable, and I may for a time carry on the records; but it will, on reflection, be seen that these observations, if continued as they should be for years, are likely to prove a serious tax upon the leisure and purse of a private individual.

Several photographs were handed round to the audience during the reading of the paper.

Professor CHEVALLIER said that having been in Spain during the eclipse, he could bear testimony to the value of Mr. de la Rue's achievements. He himself had the opportunity of making one experiment which showed that the light of the corona was brighter than that of the moon; for the light of the corona was visible through a thickness of glass, which on trying it on the moon extinguished the light. The whole scientific world was indebted to Mr. de la Rue for paying such great attention to a branch of science promising such important results, more especially as applied to the delineation of the stars. The Rev. Dr. ROBINSON thought that the matter ought not to be left with mere praise and admiration of what Mr. de la Rue had done. The means by which the Association had done so much in fulfilling its mission of a benefactor of mankind, was by acting uniformly on the principle that whenever a member was found gifted with peculiar aptitudes and powers, his services should be secured, and himself encouraged to press forward with his work. It was clear that the way was open to a new department of knowledge—that a new instrument of research was at command. Let them avail themselves of it to the fullest extent. They certainly had no right to trespass upon Mr. de la Rue's zeal or time; but he (Dr. Robinson) was sure that if they followed up the question, they might reckon upon Mr. de la Rue's assistance in directing and superintending. He hoped that an application would be made by the section to the Committee of Recommendations; and he had no doubt that the Royal Society would join in affording the means, to a great extent, of prosecuting the researches so successfully begun.—The PRESIDENT said that it was impossible to over-value the importance of the self-registration in all ways. A good many years ago, at his instance, the Association took up the subject of the self-registration of magnetic phenomena; which had been further carried out by the assistance of money from Government. It was certain that the more recondite observations became, the more it was felt that man was a very poor creature, and that matter was very superior to him. Only put a machine in order to do work, and it would do it much better than any man could. Mr. de la Rue had spoken of the precision with which he got images of the stars. The precision was so great that the images were so small that they could scarcely be made out—not from want of visibility, but because they were scarcely distinguishable from spots on the collodion. Some time ago, in America, the difficulty was the other way; for, from the state of the atmosphere, the images of the stars were in a constant shake, so that every instant there was a different image, and the result was impressions rather large and blurred. He trusted that the time would come when the transit of stars would be made to register themselves. The means were not wanting; because in America the course of a star across the field of a telescope had traced itself photographically. It would not be difficult to arrange so that this course should refer itself to seconds of time on a transit clock. The image was continuous so long as the light showed itself; but by galvanic connections with the beat of the clock, it was possible at every second to stop the light, so that a succession of images would be got, giving a distinct register of time by the star, and thus, to some fraction of a second, it can be fixed when the star passed a given point of view. He wished specially to call attention to one of the photographs—an image with the edge of the sun; and he wished all to observe the rapid degradation of light towards the edge. It was maintained by M. Arago that the light of the sun did not decrease sensibly to the edge; that it was uniform throughout. That was never his (the President's) opinion; and he gave to M. Arago some reasons for differing from him. If M. Arago did not choose to believe him, he had reasons for his doubt; but if he disbelieved the evidence of this photograph, he would have no reason for so doing. It was a matter of public scientific importance that the use of the photograph for the things now referred to should be perfectionated; and as he fully concurred in what the Rev. Dr. Robinson had said, he thought it was most desirable that the Committee should confer with Mr. De la Rue, with a view of securing that effective and direct superintendence without which, in such observations, nothing like practical advance could be made.

Several other papers were read, including one by Mr. J. H. Gladstone, "On the distribution of fog round the British Isles."

SECTION B.—CHEMICAL SCIENCE.

The meeting of this section took place at Owens College. W. A. MILLER, M.D. F.R.S. &c. Professor of Chemistry, King's College, London, took the chair a few minutes after eleven o'clock. There was a large audience. In opening the proceedings, the PRESIDENT said that in the home of Dalton, in the focus of applied chemistry, very few words would be necessary. They could not but remember that, on the last occasion when the meeting of the British Association was held in Manchester, that illustrious philosopher was still amongst them; and he trusted that the same spirit which actuated Dalton still remained in Manchester to enlighten his native country. Without saying more by way of introduction, he would call their attention to one or two points of progress during the past year. In calling attention to these subjects, he must necessarily refer to debatable ground in science,—but it was in debatable land that progress was necessarily made. He would only touch upon two or three practical applications of chemistry, and two or three theoretical ideas since they last met. The Professor then alluded to the new methods of preparing oxygen and hydrogen, proposed by Deville, which admit of application on such a scale as to allow of the generation of oxygen for manufacturing purposes, and the employment of the oxy-hydrogen blast, as a source of heat, in metallurgical operations. The novelty in the preparation of hydrogen consists in decomposing the vapour of sulphuric acid, and, by a further process, storing up the oxygen in gasholders. The preparation of hydrogen required more care. The metallurgy of platinum had already experienced a remarkable modification, owing to the application of the intense but manageable source of heat obtained by the combustion of these gases. In connection with oxygen might be mentioned a singular circumstance regarding ozone, which, according to the observation of Schrötter, had been found in a peculiar species of fluor spar, from Wolsendorf, which, when rubbed or broken, emitted a peculiar odour of ozone. The active chemist Deville, in following his researches, had discovered a variety of means of obtaining, artificially, crystallised minerals of great regularity and beauty. The methods adopted were chiefly by heating the amorphous substances in a slow current of some gas, such as hydrochloric acid, which was not an unfrequent natural product in volcanic districts. No discovery, however, had made a greater impression upon the popular mind than that of the remarkable alkaline metals cæsium and rubidium by Kirchhoff and Bunsen. These eminent men, in investigating the appearances presented by flames coloured by various metallic salts when analysed by the prism, were led, from the appearance of certain bright lines in the spectra, produced whilst they were examining a saline residuum from the waters of the Dürkheim spring, to infer the existence of a substance hitherto unknown. It was found that cæsium was present in such

minute quantity that a ton of that water, which was the most abundant sources of cæsium yet known, contained only three grains of its chloride. Taking into account the minuteness of the quantity, and its striking resemblance to potassium, it was not too much to say that the discovery of cæsium would have been impossible by any other known method than that which was actually employed. The other metal, rubidium, was somewhat more plentiful; but rubidium also so closely resembled potash that it would not have been discovered but for the peculiarity of its spectrum. Referring to the revision of the atomic weights of sulphur, silver, nitrogen, potassium, sodium, and lead, by Stass, Professor Miller said that chemist had come to the conclusion that it was not proved that the elementary bodies were multiples of the unit of hydrogen, and in opposition to the opinion of Dumas he had pronounced the law of Prout as imaginary. Every chemist would read with interest the paper by Graham upon the application of liquid diffusion to analysis. The remarkable conclusion to which the author arrived was that the process of diffusion separated all substances into one or other of two classes, which he distinguished as crystalloids and colloids. The rapid improvement in the method of analysis, though not admitting on that occasion of detailed mention, must not be overlooked. A variety of bodies formerly supposed to be of rare occurrence were now found in minute quantities, unexpectedly but widely diffused. The discovery of these small substances was by no means unimportant, for they might aid in solving problems of great interest. Glancing only for a moment at the important practical subject of the formation of steel, Professor Miller referred to the activity employed in the pursuit of the organic department of chemical science; remarking upon two lines of research as important from their theoretical bearings, namely, the investigation of polyatomic compounds, and the process of oxidation and of reduction, applied by various chemists, and by Kolbe in particular, to the investigation of the organic acids. The labours of Hofmann upon the polyatomic bases, showed completely the principle upon which these bodies might be formed, and he had been enabled to group an unlimited number of atoms of ammonia into one compound molecule. Great progress has also been made in our knowledge of the relations of the organic acids.

CHEMICAL MANUFACTURES OF SOUTH LANCASHIRE.

Professor H. E. Roscoe read a report, prepared by himself, Dr. Schunck, and Dr. Angus Smith, "On the manufactures of the South Lancashire district," of which the following is a summary:—*Sulphuric Acid:* This is an important manufacture, and quite indispensible in the production of many other articles, as well as in the manufacturing processes. To produce it economically on a large scale was of considerable importance, and a great degree of economy was practised. Few manufacturers employed sulphur, most of them using pyrites. In burning the pyrites from 8 to 10 of sulphur remained behind and was lost. Mr. Spence, of Manchester, had, however, reduced this loss to 2. The introduction of Spanish and Portuguese pyrites had caused the rise of a new branch of industry in the extraction of a small quantity of copper which these ores contain. In Hill's process of purifying gas, hydrated peroxide of iron was used instead of lime. When the material could be no longer used for purification it was found to contain sulphur, and Mr. Spence used this sulphur for the production of sulphurous acid. From one ton of the material he obtained about 1¾ ton of hydrated sulphuric acid. Mr. Harrison Blair's improved sulphur burner was especially valuable, as economising space in the chambers, from preventing the sulphurous acid from being diluted with too large an excess of air, as is the case in the ordinary burners. The tendency in this district has been to increase the size of the sulphuric acid chambers, the largest being 112,000 cubic feet. Many manufacturers employ Gay-Lussac's method, invented 16 or 17 years ago, for economising nitric acid. By this means a saving of more than 50 per cent of nitrate of soda is effected; but others do not employ this method, as with the low price of nitrate of soda, at £12 per ton, it does not pay to collect and absorb the waste oxides of nitrogen. The use of platinum stills for the rectification of sulphuric acid has now been almost entirely abandoned, and their place supplied by glass retorts, which are made larger and of better quality than formerly. The weekly production of sulphuric acid of specific gravity 1·85, exclusive of what is used in the manufacture of soda ash, is 700 tons. *Soda:* This is a most important manufacture. Few changes in the principle of manufacture have taken place during the last ten years, the essential points of the original method of Leblanc (1798) being still adhered to. The extent of the manufacture has largely increased since the year 1851. The value of alkali made annually in England is £2,000,000; of this, half is made in South Lancashire and half in the Newcastle district. The following statistics apply to the South Lancashire alkali trade, per week, in 1861:—Common salt decomposed per week, 2,600 tons; sulphuric acid used, 3,110 tons; hydro-chloric acid produced, 3,400 tons; soda ash sold per week, 1,800 tons; salt cake sold per week, 180 tons; soda crystals ditto, 170 tons; bi-carbonate soda ditto, 225 tons; and caustic soda ditto, 90 tons. Since 1852 the alkali trade of South Lancashire has more than tripled. The large quantity now produced is manufactured in about twenty-five works, chiefly situated at St. Helens, Runcorn Gap, Widnes Dock near Warrington, the neighbourhood of Bolton, and Newton Heath. None of the patents for improving the manufacture of alkali had changed the process materially. The improvements of detail since 1851 have been the following:—1. Greater attention to economical working in all the branches. 2. The process of lixiviation of black ash is more completely accomplished than formerly, by the arrangement of Mr. Shanks. 3. In some works the black ash is now made by machinery. 4. The soda is now in many alkali works packed in casks by machinery. Since 1851, a new branch of the manufacture has been introduced by the preparation of solid caustic soda, which is largely exported to America and other places, by Evans and M'Bryde, and Roberts, Dale, and Co. The proposition recently made by Kuhlmann of the employment of the alkali waste as a cement is a very old idea, Mr. Deacon, of Widnes, having used it for making floors for 12 years. In conclusion, the report recognised the important additions to our knowledge of the theory of soda manufacture made by Mr. Gossage. *Bleaching Powder:* 155 tons of this powder is made in this district. The only remarkable points in the manufacture are an ingenious process of preparing chlorine without the use of binoxide of manganese, patented in 1858 by Mr. Shanks, of St. Helens, and the regeneration of peroxide of manganese from the waste liquors containing chloride of manganese. *Chlorate of Potash*: From four to five tons of this salt are made weekly in this district, and it is used for match making. *Hyposulphate of Soda:* Three tons weekly is made, and is used by paper makers, photographers, and by bleachers, as an antichlor. *Silicate of Soda:* This compound is used as a substitute for cow dung in calico printing, and by soap manufacturers in place of the resinates formerly in use. About ten tons weekly are produced in this neighbourhood. *Arseniate of Soda*: This salt is used as a substitute for cow dung in calico printing, for which purpose it is better adapted than the silicate of soda, as it does not so much attack the alumina mordants. Ten or twelve tons are produced weekly in this neighbourhood. *Bichromate of Potash*: There is nothing new in the manufacture of this salt. About 14 tons are produced weekly in the district. *Prussiates of Potash*: From four to five tons of yellow prussiate of potash, and one ton of red prussiate, are produced in this district weekly. *Superphosphate of Lime*: The weekly production in this district is 5,600 tons. *Alum*: Before 1845 the alum manufactured in this district was confined to a small quantity from pipeclay, our chief supplies being derived from Whitby. By the old process 60 tons of the oolitic shale of Yorkshire was re-

quired to produce one ton of potash alum and one ton of Epsom salts. By Mr. Spence's process, 50 tons of shale yield 65 tons of ammonia alum. Mr. Spence employs the shale found underlying the seams of coal in this district. In 1850-51, Mr. Spence made about 20 tons per week. The quantity now made by him amounts to 110 tons. Fully half of the total quantity manufactured in England (300 tons per week) is made by this process.—*Protosulphate of Iron*: This salt is manufactured in large quantities in this district, principally for the use of dyers, the amount being about 80 tons per week.—*Pyroligneous Acid*: The only improvement introduced into the manufacture of this acid during the last few years consists in the use of sawdust instead of wood in the process of destructive distillation. The quantity of acid manufactured weekly in Manchester is 12,000 gallons, containing about 4 per cent of glacial acid. The value of the acid is £3 per ton, whilst that of the tar is £4 to £4. 10s.—*Compounds of Tin—Chlorides of Tin*: The quantity of these compounds (estimated as crystallised protochloride of tin) manufactured in this district amounts to about 16½ tons per week.—*Stannate of Soda*: This compound has for some time been extensively used for the purpose of preparing calicoes which are intended to be printed with so-called steam colours.—*Sulphate of Baryta*: Of this salt, which is usually sold under the name of Blanc fix, about two tons are made in this district by precipitation.—*Nitric Acid*: About 48 tons of nitrate of soda per week are used in this district for making nitric acid. The salt yields its own weight of acid sp. gr. Nitric acid is used here for making the nitrates of copper, lead, alumina, and iron, for oxydising tin, for etching, and latterly for making aniline. — *Oxalic Acid*: One of the most important and interesting of the new manufacturing processes, is one for the preparation of oxalic acid, invented and patented by Messrs. Roberts, Dale, and Co. gentlemen to whom we owe a number of highly ingenious and useful practical processes. The quantity of acid manufactured by Messrs. Roberts and Dale amounts to nine tons per week, with capabilities of extension to upwards of 15 tons. To give an idea of the effect which the introduction of this process has had on the market, it may be mentioned that the selling price at this time is 8d. to 9d. per lb, whereas, in 1851, it was 15d. to 16d. per lb. Oxalic acid is used extensively in calico printing, woollen, dyeing, woollen printing, silk dyeing, with wood colours, in straw bleaching, and for making binoxalate of potash so called " salt of lemons," *Starch and Artificial Gums*: About 20 tons of starch and 34 tons of gum substitutes, made by roasting farina and other kinds of starch, are produced in this district per week. *Purification of Resin*: Several very interesting and successful processes have lately been patented by Messrs. Hunt and Pochin, of Salford, for the purification of resin. The aim of these gentlemen, who have devoted a large amount of time and attention to this subject, is to produce a bright, nearly colourless, solid and brittle resin, from the common dark and impure commercial article. About 60 tons per week of this clarified resin is now manufactured in this district, under this patent. *Organic Colouring Matters*: There are few substances of more importance to the manufacturers of this district than those which are employed in imparting colours to the various fabrics, especially those of cotton, produced here. Of these substances, the majority are derived from the animal or vegetable kingdom. Indeed, with the exception of oxide of iron and chromate of lead, very few mineral substances are at the present time made use of alone by the dyer or printer. The great intensity, beauty, and variety of the dyes which are wholly or in part composed of organic matter, causes them to be preferred, and the increase of skill and knowledge of scientific principles on the part of dyers and printers, have also led to their more exclusive employment, when it is stated that the quantity of dyewoods (logwood, peachwood, saffronwood, barwood, fustic, quercitron bark) consumed weekly by the dyers of this district amounts to 300 or 400 tons, that the weekly consumption of the same by printers is about 50 tons, that from 150 to 200 tons are in the same time converted into extracts, that 150 tons per week of madder are used up, exclusive of what is used for garancine, &c. some idea of the magnitude of the interests depending on the employment of the materials may be formed. With the exception of a new method of reducing indigo by means of finely divided metals, patented by Leonhard, we do not suppose that any important improvement has been introduced in connection with this dye stuff. Of less importance in the art of dyeing is madder, the material with which the most permanent reds, purples, and blacks are produced. The methods which have been proposed for more effectually utilising this important dye stuff are very numerous indeed, though exceedingly few of them have been found to be of practical value. They may be divided into two classes, viz. those having for their object to render available the greatest amount of colouring matter, and those which tend to produce more permanent or more beautiful colours. The first object seems to be perfectly attained by converting the madder by the action of acid into garancine. This preparation is becoming more and more extensively used.—*Aniline Colours*: The artificial colouring matters from aniline and other bases have of late attracted much attention, and various plans have been devised for producing them. The usual method of obtaining aniline purple, the so-called " mauve " consists in submitting salts of aniline in watery solution to the action of oxidising agents, such as chromates, permanganates, or the peroxides of manganese and lead. *Disinfectants*: The manufacture of disinfectants has become a regular and constant one, and since the inquiries instituted on the subject by one of us and Mr. M'Dougall, of this city, the use of those made in this district has been enormously increased. Mr. M'Dougall manufactures, near Oldham, a disinfecting powder, in which the properties of carbolic and sulphurous acid are taken advantage of. This is used to prevent decomposition in stables, cowhouses, and among accumulations of putrescible matter, and generally for the prevention of decomposition in manures. A liquid is also prepared with carbolic acid and lime water, which is applied for the purpose of preventing decomposition in sewers, according to the idea entertained by one of us, of purifying whole cities by preventing the generation of gases in sewer water or among accumulations of animal refuse. The liquid is also used to prevent the decomposition of animal matter when it cannot at once be made use of, especially in the case of meat brought to market, or animals that have died in the field. The solution of the powder has also been used, to some extent, in dissecting rooms, where it immediately destroys any noxious smell, and at once liberates the fingers of the operator from the peculiarly nauseous odour which so often attaches to them. It has also been found useful in the treatment of sores, as well as of dysentery. Mr. M'Dougall has also applied carbolic acid to the destruction of parasitic insects on sheep, and has in many districts entirely driven out the arsenical preparations by the use of this acid united with fatty substances. Sheep dipped in it are not liable to be attacked by tick, even when left for some months among other sheep infected with it. Foot-rot, and other diseases of sheep, are also said to be prevented and cured by its use.—The report, having been read, a short discussion followed, in which Mr. Spence and Mr. Rumney took part, and they expressed themselves much interested in the details of the report ,and considered great praise was due to Professor Roscoe, and Doctors Smith and Shunck, for the able manner in which it had been made.

Dr. Andrews read a paper "On the effect of great pressure combined with cold on the six non-condensible gases." A paper (by Dr. Joule and Professor W. Thomson) was read, " On the thermal effects of elastic fluids."

The President announced that in consequence of the absence of Dr. Crace-Calvert, his papers " On the chemical composition of some woods employed in the navy," and " On the chemical composition of steel," would be postponed.

SECTION C.—GEOLOGY.

This section met in the Lecture-room of the Royal Institution, under the presidency of Sir R. I. MURCHISON. The attendance throughout the sitting was very large, and the papers and discussions occupied until nearly four o'clock.

The PRESIDENT said that he should not occupy time by alluding to the engrossing subject of the most recent natural operations with which the geologist had to deal, and which connected his labours with those of the ethnologist. On this head he would only say, that having carefully examined the detrital accumulations forming the ancient banks of the river Somme, in France, he was as complete a believer in the commixture in that ancient alluvium of the works of man with the reliquæ of extinct animals, as was their meritorious discoverer, M. Boucher de Perthes, or as their expounders, Prestwich or Lyell, and others. He might, however, express his gratification at learning that our own country was now affording proofs of similar intermixture both in Bedfordshire, Lincolnshire, and other counties; and, possibly, at this meeting they might have to record additional evidences on this highly-interesting topic. But he passed at once from any consideration of these recent accumulations, and, indeed, of all tertiary rocks; and, as a brief space of time only was at his disposal, he would only lay before them a concise retrospect of the progress which had latterly been made in the development of one great branch of our science. He confined himself, then, to the consideration of those primeval rocks with which his own researches had for many years been most connected, with a few allusions only to metamorphism, and certain metalliferous productions, &c. There was, indeed, a peculiar fitness in dwelling more especially on the ancient rocks, inasmuch as Manchester was surrounded by some of them, whilst, with the exception of certain groups of erratic blocks and drift, no deposits occurred within the reach of short excursions from hence, which were either of secondary or tertiary age. The President then took a retrospective view of the progress which has been made in the classification and delineation of the older rocks since the Association first assembled at York, in 1831.

SKETCH OF THE GEOLOGY OF MANCHESTER.

Mr. E. W. BINNEY, F.R.S. F.G.S., of this city, gave a succinct account of the geological features of the neighbourhood of Manchester. He described the several beds of gravel, sand, and till, forming the superficial covering of the district:—1st, The valley gravel, with its successive terraces; 2d, the widely-distributed upper sand and gravel; 3d, the great deposit of boulder-clay or till, which is at some places 90ft. thick, and yields the brick earth of the vicinity; 4th, a lower bed of gravel. The under-lying rocks or skeleton of the country, known chiefly by boring operations, were then treated of, viz.:—1st, The trias, or upper red series, about 500ft. thick; 2d, the lower new red or permian series, including a pebble bed, marls, sandstones, and limestones with gypsum, amounting to 600 feet altogether. These overlie the coal measures, and have been pierced in search for coal at Medlock Vale and elsewhere. These beds were regarded by the lecturer as equivalent to the lower permian beds of Yorkshire. The lower bed of conglomerate is found to thicken out northward in Cumberland and Scotland to some thousand feet in thickness. 3d. The coal measures of the Manchester coal field, as proved by borings, and by the few local exposures a Ardwick and elsewhere. All of these are exceedingly dislocated—one fault having certainly a down-throw of 1,050 yards at one place, and of 50 yards some miles off, and another showing far greater disturbance, some of the faults showing much evidence of a lateral motion. The lecturer regarded these faults as having been formed for the most part immediately after the carboniferous era, and they were further shifted after the permian period. The lecturer illustrated his remarks by a geographical sketch map of the district, showing the distribution of the superficial clays, gravels and sand, another showing the arrangement of the lower rocks, as far as yet determined; and by three sections of the district—one from Trinity Church to Waterhouses, another from the Exchange to Smedley, and the third from Eccles to Kersal Moor.

After some general remarks by the President, Professor PHILLIPS said they were deeply indebted to Mr. Binney for the admirable remarks he had made upon the stratification of the surrounding country, for the examination had been carried on with advantages which nobody else could have. He concurred with Mr. Binney's statements, and dwelt upon the probable unconformity between the coal measures and the permian beds, and on the probable age of the faults, and their relationship to each other and to the old land and water surfaces in palœozoic times, which was a point of much interest. As Mr. Hull was in the neighbourhood surveying this part of the country on behalf of the Government, he hoped he would offer some remarks upon the subject. Mr. E. HULL, B.A. F.G.S. said he should feel himself guilty of a dereliction of duty if he let the opportunity pass of returning, on behalf of himself and his colleagues in the survey now in progress in this district, their thanks to Mr. Binney for the readiness with which he had placed at their disposal the vast amount of general and local information he possessed. It would be well for the progress of the survey if every large town was furnished with such a distinguished geologist as Mr. Binney. If such were the case they should indeed be saved a vast amount of labour, and often saved from error and mistake, passing, as they were, rapidly through the country. Mr. Hull then made some observations on the river terraces (five or six in about 150 feet) of the Irwell, and on the triple arrangement of the drift deposits, viz. upper sand, intermediate or boulder clay, and lower sand. He also dwelt on the unconformity of the permian to the triassic beds. Mr. Hull objected to Mr. Binney's view as to the eroded condition of the faults; and as to the age of the faults, some of which, the Pendleton fault, (for instance), he thought might have been brought about even in the oolitic period. — Mr. BINNEY offered some explanations with regard to what he considered were misconceptions on the part of Mr. Hull. For instance, Mr. Hull objected to the theory of erosion with regard to the Pendleton fault extending to beyond Pendleton; but that dislocation, though extending 1,050 yards at this end, at a distance of 15 miles it was only 50 yards.—Mr. J. B. JUKES, M.A. F.R.S. the director of the Irish Survey, thought it quite possible to reconcile Mr. Binney's views with Mr. Hull's, and that both might be right. His knowledge of the South Staffordshire coal-field led him to think that the views of both gentlemen as to the dislocation and erosion of this district might be reconciled; and a practical point of immense importance was involved in a knowledge of these old faults, denudations, and fillings up with respect to coal measures and the search for them beneath the new red and other rocks in this and other districts. He pointed out the incompatibility of one formation with another, and people, if they did not feel strong in theoretical geology, should, before acting, be careful to take a sound opinion.—Mr. ROBERT CHAMBERS asked Mr. Binney if the till of Manchester was subdivided, like that of Scotland, into overlying brick earth and the till proper?—Mr. BINNEY replied that, in the neighbourhood of Manchester, the upper surface of the till was generally worked for brick earth. Some went six or eight feet down, and the only reason they assigned for that was that it was freer from pebbles.—Mr. C. MOORE made some remarks as to the occurrence of axinus and plesirophories in triassic as well as in permian beds.—Mr. SALTER referred to the important results of Mr. Binney's researches in the fossils of the coal measures, as illustrative of the extent and distribution of the flora and fauna of the carboniferous period.—A vote of thanks was then accorded to Mr. Binney for the valuable information he had imparted.

At this point of the proceedings, the PRESIDENT stated that he had received a communication from the Mayor of

Manchester offering the use of the Town Hall for the meetings of Section C. They must all have perceived the great inconvenience they were placed in, with no platform, no place for the vice-presidents, and no provision for the reporters; and, in addition, it was exceedingly difficult for any one to make himself heard by all in the room.—Professor PHILLIPS observed that they had tried the Town Hall on the previous day, and his experience was, that what was said there was not heard at all, and what was said in the place they were then assembled in was very little heard.—Under these circumstances, it was resolved not to remove to the Town Hall.

The PRESIDENT announced that he had been requested to attend another section, to give his opinion on a geographical subject, and at his request General Portlock, one of the vice-presidents, took the chair during his temporary absence.

ENCROACHMENTS OF THE SEA.

Mr. W. PENGELLY, F.G.S. read a paper on the "Recent encroachments of the sea on the shores at Torbay." Hard Devonian limestones, fissile and round jointed, formed, he said, the two projecting horns of Torbay, sandstones and conglomerates form the hollow of the bay, and have been much worn away within the memory of man, especially at Livermead, which is only preserved by continual engineering labour. The process of erosion by the sea was explained by the author as something like a succession of honeycombing, sometimes by insulation of portions of the cliffs. On the slates and limestones the sea more slowly produced excavations and ledges, which storms enlarge. The effects of the severe storm of October, 1859, on the cliffs, beach, roads, &c. of Torbay were described in detail, and the importance of such storms as modern agents of change was dwelt upon.

Mr. G. W. ORMEROD, M.A. F.G.S. corroborated Mr. Pengelly's remarks as to the effects of the storm of 1859, and said those who had seen the effects of an inland torrent at Holmfirth would, by going to Torbay, see what a wave of the sea could do. He recommended that locality to the study of visitors.

EXCESS OF WATER IN THE NEW ZEALAND REGION.

Mr. JAMES YATES, F.R.S. F.G.S. then commenced a paper on "The excess of water in the region of the earth about New Zealand: its causes and effects." The author stated that as it is generally regarded that one-half of the moon is heavier than the other half, he thought there was nothing absurd or violent in the idea that the half of the earth to which New Zealand belongs, that is, the "water hemisphere," is heavier than the other half forming the "land hemisphere," and he thought it would not be extravagant to prove the unequal weight of the two halves of the earth. The land and water hemispheres of Berghans were then described. The average elevation of the mountains in each of these hemispheres (as explained by a table) shows that the water rises higher in the "water hemisphere" than in the other—the average height being 5,508 metres in the "land hemisphere," and 3,604 metres in the "water hemisphere." He ascertained that the proportion of land to water was as 289 to 100, or as 10° to 17°. The possible causes of the "tumefaction" of the land in the one hemisphere were next discussed—Herschel's opinion being especially quoted. Mr. Yates exhibited a diagram of the mathematical centre of the atmosphere and of the ocean, and centre of gravity of the atmosphere and terraqueous globe. He referred to the collapsing hoop-petticoat as illustrative of the meniscoid form of the accumulated waters in the region under notice.

Before the conclusion of the lecture, the PRESIDENT (who had resumed his chair), observed that he thought the subject, though very interesting, more fitted for discussion in Section E—the Geographical Section.—Mr. HENNESSEY remarked that he thought the earth is not a perfect spheroid, and that the cause of the unequal distribution of water may be due to that cause.

Mr. CHARLES MOORE then made some remarks "On the Nodules containing Ichthyosaurian Remains from the lower part of the upper lias of Somersetshire." The vertebræ, paddles, and other parts of the skeleton, also the eye, the skin, the contents of the stomach, and even the ink-bag of the undigested cuttle fish have been carefully exposed, by the careful manipulation of one of the nodules. The specimens were exhibited by Mr. Moore in a developed state, they having been exhibited at a previous meeting at Cheltenham in an undeveloped state, on which occasion Mr. Moore promised to produce them at a future meeting properly developed. Another specimen commented upon was a nodule untouched, and represented a stone "mummy" of another ichthyosaurus, upwards of five feet long, which Mr. Moore expected to find in a most perfect state of preservation, when he could work it out. This, he believed he could also show, fed upon the cuttle fish millions and millions of years ago. He invited the Association to pay a visit to Bath at an early period, and promised by that time to have the second specimen developed.—The PRESIDENT said from what he knew of Mr. Moore, if the Association did go to Bath, they would see still greater and more important illustrations of his power as a comparative anatomist.—Professor PHILLIPS suggested that both the nodules should be photographed before they allowed them to leave Manchester, and then, if they ever went to Bath, as he hoped they should, they would be able to see how Mr. Moore fulfilled his promise.—Mr. JONES said he had seen specimens of the kind in the upper clays of Ilminster, lying as thickly as bones in a graveyard.—Sir. J. EMERSON TENNENT asked if the second specimen produced was not a plesiosaurus, instead of an ichthyosaurus?—Mr. MOORE and Professor OWEN replied that it was an undoubted specimen of the ichthyosaurus.

Mr. J. G. MARSHALL read a paper "On the Relation of the Eskdale Granite at Blackcomb to the Schistose Rocks." The author first referred to the observations which he offered last year to the Association on the igneous and metamorphic rocks of the southern portion of Cumberland. He then described the granite under notice and its relation to the schists, and considered it as exhibiting a metamorphosed condition of some beds of clay slate. Other granite rocks of the district were also described, and similar conclusions as to their nature were arrived at. Those granite rocks that the author finds to be more fusible, he regards as having been most altered; the less fusible rocks he believes to have been converted into porphyry. He has been able to trace in specimens the passage from granite, through porphyry, into the ordinary schistose rocks. He regards the granite as having been neither eruptive nor intrusive; and he stated that the granite does not give rise to a periclinal axis. General considerations on the nature of granite, its relations to the contortions of the earth's crust, and its probable metamorphic character were then offered; and this rock was contrasted with ordinary lava, and the improbability of the latter being connected with the molten central mass of the earth, was dwelt upon.—The PRESIDENT said, from his acquaintance with metamorphic rocks, he attached great value to the observations of Mr. Marshall. He expressed his regret that Professor Sedgwick, who took great interest in the subject, had not been present during the sitting.

Professor PHILLIPS addressed the meeting at considerable length on the subject of the paper, and alluded especially to the variation of characters in granite and porphyritic dykes and veins, and their relations to masses of true granite, as well as to metamorphic slate-rocks, and on the natural changes which these rocks appear to have had one on another. He also observed that in different localities these conditions were infinitely varied.

Mr. SCOTT promised some remarks at a future period on the granites of Ireland, and their relations to metamorphic rocks, gathered from a tour in Donegal.

The section then adjourned.

SECTION D.—ZOOLOGY AND BOTANY.

This section commenced its sittings in one of the largest rooms of the Royal Institution. In consequence of the

presence of Professor Owen, M. Du Chaillu, and other eminent men, a large amount of public interest was excited, and the room during the greater part of the day was crowded to excess.

The President, Professor Babington, M.A. F.R.S. said he had not prepared any opening address, because he felt it would be a mere waste of time, unless it were of the most scientific character. He did not anticipate that any feeling of warmth would be elicited by the discussions which might take place, but if this should unfortunately occur, he depended on the meeting to second his efforts to maintain order.—(Hear, hear.)

Professor Owen read a brief but interesting paper, "On the construction of the vertebræ of the common mole," observing that his main object was to induce the younger comparative anatomists to exercise their skill on indigenous subjects.

PROFESSOR OWEN ON M. DU CHAILLU'S DISCOVERIES.

Professor Owen afterwards read a paper on some objects of natural history from the collection of M. Du Chaillu, of which the following is a summary:—Professor Owen's first knowledge of the zoological collection was derived from a letter sent by M. Du Chaillu, dated Gaboon, June 13, 1859, and received in the British Museum in August, 1859, in which M. Du Chaillu specified the skins and skeletons of the gorilla or n'gena, kooloo namba, nschiego, and nschiego-mborives which he had collected, offering them for sale, with other varieties, to the British Museum. Professor Owen replied, recommending the transmission of the collection to London for inspection, with which recommendation M. Du Chaillu complied, bringing with him all the varieties he had named with other objects of natural history, from which he permitted selections to be made. The skins of the adult male and female of the young of the troglodytes gorilla afforded ample evidence of the true colouration of the species. In the male, the rufo-griseous hair extends over the scalp and nape terminating in a point upon the back. The prevalent grey colour is produced by alternate fuscous and light grey annulations of each hair, extends over the back, the hair becoming longer upon the nates and upon the thighs. The dark fuscous colour gradually prevails as the hair extends down the leg to the ankle. The long hair of the arm and forearm presents the dark fuscous colour; the same tint extends from below the axilla downwards and forwards upon the abdomen, where the darker tint contrasts with the lighter grey upon the back. The scanty hair of the cheeks and chin is dark; the pigment of the naked skin of the face is black. The breast is almost naked, and the hair is worn short or partially rubbed off across the back, over the upper border of the iliac bones, in consequence, as it appears, of the habit ascribed by M. Du Chaillu to the great male gorilla of keeping at the foot of a tree, resting its back against the trunk. The skin of the great male gorilla, as mounted in the British Museum, exhibits two opposite wounds,—the smaller in front on the left side of the chest, the larger close to the lower part of the right blade bone. Two of the ribs in the skeleton of this animal are broken on the right side near where the charge had passed through the skin in its course outwards. These marks correspond with the account of the slaughter of the great gorilla given by M. Du Chaillu. Professor Owen proceeded to describe the colour of the female gorilla, which, it appears, was generally darker and of a more rufous tint than the male. In one female the rufous colour so prevailed as to induce M. Du Chaillu to note it as a red-rumped variety. In the young male gorilla, 2ft. 6in. in height, 1ft. 7in. in the length of the head and trunk, and 11 inches across the shoulder, the calvarium is covered with a well-dressed "skull-cap" of reddish-coloured hair. The back part of the head behind the ears, the temples and chin are clothed with that mixture of fuscous brown and grey hair which cover with a varying depth of tint the trunk, arms, and thighs. The naked part of the skin of the face appears to have been black, or of a very dark leaden colour; a few scattered straight hairs, mostly black, represent the eyebrows. A narrow moustache borders the upper lip, the whole of the lower lip and sides of the head are covered with hair of the prevailing grey fuscous colour. The rich series of skulls and skeletons brought home by M. Du Chaillu illustrate some most important phases of dentition. These phases were specified by Professor Owen at length. The deciduous or milk dentition, it was remarked, were in the youngest specimen of the gorilla something similar to those of the human child, but an interspace equal to half the breadth of the outer incisor divides that tooth from the canine, and the crown of the canine descends nearly two lines below that of the contiguous milk molar. The deciduous molars differed from those of the human child in the more pointed and penchant shape of the first, and much larger shape of the second. The dentition of the young gorilla corresponds best with that exemplified in the human child between the eighth and tenth years; the difference, however, is shown in the complete placing of the true molar, whilst the premolar series is incomplete. It was worthy of remark, also, that in both specimens examined the premolars of the upper jaw had preceded those of the lower jaw, and that the hind premolar has come into place before the front one. In the later development of the canines and the earlier development of the second molars of the second dentition the gorilla differs, like the chimpanzee and the orangs from the human order of dental development and succession. An opportunity of observing this order in the lower races of mankind is rare. Professor Owen availed himself of the opportunity in the case of the male and female dwarf earthmen from South Africa, exhibited in London. He found dentition at the phase indicative of the age of from seven to nine in the English child; other indications agreed with this evidence of immaturity. The children were altered and exhibited as adults. Both showed the same precedency in development of canines and premolars which obtains in the whole race. Referring next to the variety of the chimpanzee, brought by M. Du Chaillu from the Camnia country and from near Cape Lopez, Professor Owen remarked that this species accords specifically in its osteological and hirsute development with the troglodytes niger. It is stated by M. Chaillu to be distinguished by the natives of Camnia as the nschiego mborive from the common chimpanzee *(troglodytes niger)*, called by them the nschiego. From the character of the skins of the male and female specimens of this species brought by M. Du Chaillu to London, Professor Owen would have deduced evidence of a distinct and well-defined variety of troglodytes. In the remainder of the paper, Professor Owen compared the specimens brought home by M. Chaillu and the ordinary chimpanzee.—He concluded amidst hearty applause.

In answer to a question, Professor Owen stated that he knew of nothing yet which explained the peculiar habits of the gorilla. All they knew at present were absolute facts.—In reply to a further question as to what sum had been paid by the British Museum to M. Chaillu for the collection he had placed in their hands, Professor Owen said that M. Du Chaillu had shown no greediness after money—(hear, hear);—but dealt in the most handsome, liberal, and gentlemanly manner. — (Applause.) Professor Owen further observed that we had no evidence of a taller gorilla than one 5ft. 4in. in height. It was the body of a giant placed upon the legs of a dwarf.

M. Du Chaillu was here introduced, and received an enthusiastic welcome. He said: Let me thank you for the kind feeling extended to me here as everywhere since my arrival in England. I meet with such kindness always that I love your country as much as an Englishman can do.—(Applause.)

Several questions were asked M. Chaillu, who stated, in reply, that the gorilla was exceedingly strong in the arm. A gorilla once broke the ribs of a servant of his, who died in consequence. He had frequently seen them snap branches of hardwood two inches in diameter. The animal was very fond of the sap of certain trees. The only thing he had seen was that those trees were broken almost before him, and they measured about 4 in. in diameter. He did not say it was the hardest wood but it was tolerably

hard wood, and he could see on the tree the gnawings of the gorilla's tusks. The arm of the animal was exceedingly powerful, but he could not say exactly for what object it was so created. He had seen a man knocked down by it, who died. The gorilla did not go much upon trees; the large ones he never saw upon trees. He imagined that the arm of the animal was its chief means of defence, for when the monster advanced to the attack he used this powerfully strong arm, which was so long that if it took hold of them that would be their end. (Laughter.) He did not know of any animals that fought with the gorilla; he never saw such combats. He had heard accounts of them, but he fancied that they proceeded more from the imagination of the natives than from truth. He wished he had seen a fight between a leopard or elephant and a gorilla; but he doubted if such contests took place. He thought each of these animals would be shy of one another, being so powerful. Professor Owen had seen in the British Museum one of these animals with a broken arm, which the Professor had told him he thought was from the blow of a gorilla. He was now of the same opinion, because the ribs of the man who was killed were broken, and the gorilla was strong enough to break any man's arm. M. Du Chaillu said the beating of the animal's chest with its long arms sounded like the beating of a drum, and it must require tremendous power to bring such sounds out of bones and muscles. He thought this was the most formidable part of the monster, and described it as a terrible sight to see him beat his chest. It was true the beast was ugly enough in himself, but this beating on the chest frightened him the most. (Laughter.) M. Du Chaillu next described the awkward attempts of the gorilla to walk. They had to sit down, and rest, after going a little distance, because they walked with the greatest difficulty. The body was too large to be supported on its short and crooked legs. He hoped other travellers would follow him, so that more might be known about the habits of this wonderful beast. The little he had made known would, he hoped, incite others to discover more. (Applause.)

Mr. ELLIOTT: What is the nature of the country inhabited by your troglodytes? Is it subject to inundation?

M. DU CHAILLU: Yes. All that part of Africa is subject to inundation. It rains nine months of the year there.

Mr. ELLIOTT: That probably induces it to form a habitation in the trees. (Hear.)

Dr. LANKESTER had no doubt that this large audience had been attracted, not only on account of the reputation of the distinguished author of the paper which they had just heard, and also the reputation of the great traveller who had just spoken, but he believed there was an interest in these creatures independently of the important circumstances that surrounded them. He thought there were many present who had a lively recollection of the discussions which took place last year at Oxford, when that great theory of the production of species was brought forward so often; and they would also recollect that there were expressions at that meeting which would seem to indicate that some naturalists, at least, were not unprepared to believe that through a development, or through changes which went on in the animal world, the gorilla might have been, in past ages, the originator of man—he would not say the direct parent. This question assumed great importance in the present day. There were many persons who did not hesitate to announce this as their belief, and the audience would be deeply obliged to Professor Owen if he would point out what he thought was the difference between these great monkeys, which were supposed to be most closely related to man, and man himself. (Hear, hear.)

Professor OWEN said he rose with great pleasure to endeavour to respond to the request of his fellow-labourer, Dr. Lankester; knowing, however, that what he had to say would be nothing new to his zoological friends. If he were to express what he felt after the discussions which had taken place on the resemblances and the differences organically between the anthropoid apes and man, it would be somewhat as follows: First, of course it must be borne in mind that our organical philosophy had long since shown that man was no exceptional speciality in animal structure, but as it were the sum and crown of the series of developments that were to be traced from ourselves down to the lowest of the vertebrated series. For example, taking the skull of a cod fish, one could point out on that head about 95 per cent. of the bones in our own head, and they were called by the same names, being in the same relative positions, and having the same general relation to the nerves and parts of the brain and vessels. Well, when that could be done in a generally progressive and increasing degree from the fish up to man, they saw at once what a close general conformity of fundamental type our body was built out of. As we approached nearer to man that resemblance became more and more close, and consequently the difference became more and more interesting and important. What then were the differences between the gorilla and the boschman, the negro, or the lowest in form of our species? First, there was a difference in the position of the innermost digit of the lower limb. In the gorilla it was turned at a greater or less angle from the other digits, and was in fact an opposable digit; it was a thumb; it was not a great toe, as in man, nor parallel with the other toes; it was relatively stronger than the other digits, and was associated with a broader foot, having the heel bone flatter below; it was also associated with a different relative position of the joints upon which the leg rested, with other modifications to give a broader basis of support to the whole frame. Then there were corresponding modifications of essentially the same bones throughout the vertebral column and the ribs. In man a greater number of the lumbar vertebræ were left free, and the ribs were limited to twelve pairs; there were thirteen in the gorilla. Next, the upper limbs were made in an harmonious kind of proportion to the lower limbs, not longer, but somewhat shorter. Every joint showed as it were a perfection of structure. The thumb of the hand was made relatively larger, and could be applied more distinctly as a prehensile organ to each digit, so that it became a perfect instrument and organ of free will and rational intelligence. These differences were associated with still greater modifications of the skull. There were the same bones and the same relative position, but there was an almost hydrocephalous expansion of the head in man as compared with the gorilla. The brain cavity in man was a fine globular part, with which we associated the idea of highest beauty, and the Greeks exaggerated it to show that beauty; yet there was a connection between the vast head of man and the mere spines sticking up in the head of a fish. (Applause.) In the brain itself there was a marked and certainly a sudden increase of size in all directions, which was due chiefly, if not wholly, to one particular part of the brain called the cerebral hemispheres. Professor Owen pointed out other and more abstruse differences between the structure of man and the ape, which, though apparently unimportant in themselves, were of the highest significance when viewed collectively and in contrast. The gorilla maintained an erect position with difficulty, and hobbled in an awkward manner rather than walked, being obliged to sit down and rest every twenty yards before he could come up to the attack. (Laughter.) What were the other great differences between man and the ape? There was first the marked difference of speech. This was the one great distinction between every variety of our race and all the lower animals, with whom there was no nearer approach to it than the utterance of a kind of instinctive cry, a roar and bellow of rage, or a shriek of alarm; this was all that the highest apes could do in the way of speech. He confessed his entire ignorance of the mode in which it had pleased our Creator to establish our species, as it was said, "out of the dust of the earth." By what marvellous process all that might be accomplished was not told to us, nor need it be. Without, therefore, having any kind of idea in his own mind, or any sense of a proof, or a demonstration, or an approximation, how man originated, he was quite open to any evidence that might be vouchsafed to us, and if in future investigations we should get a little more satisfactory insight into the origin of our own species, they would most gladly accept it.

The subsequent proceedings of the section were as follows:—Mr. J. Gwyn Jeffreys, F.R.S. exhibited specimens of the sphœnotrochus borealis of Fleming, from Zetland. Dr. Ogilvie read a "Report of the Dredging Committee on the north and east coasts of Scotland." Dr. Thomas

Alcock read a paper "On the anatomical characters of Cypræa." M. T. Masters, F.L.S. contributed a paper "On the relation between pinnate and palmate leaves;" and Dr. Dickie read a "Report on the flora of the north of Ireland."

On each subject a brief discussion took place, but nothing of great importance was elicited. Professor Wyville Thomson's "Observations on the development of Synapta inhærens," which were to have been read by Mr. R. Patterson, had not arrived. Some specimens of the Synapta inhærens were exhibited by Mr. Patterson, and the subject was deferred until the morning.

The section adjourned about half-past two o'clock.

SUB-SECTION D.—PHYSIOLOGY.

This Sub-section met in one of the small exhibition rooms at the Royal Institution, Dr. DAVY, F.R.S. presiding.

CHLOROFORM ACCIDENTS.

The first paper read was "On chloroform accidents, and some new physiological facts as to their explanation and removal," by Dr. Charles Kidd. The author held that "there is every reason to hope that in consequence of more correct opinions now entertained in hospital practice on the administration of chloroform, that the deaths from that agent will disappear altogether, as they have been manifestly diminishing in proportionate frequency during the last twelve months, now that these accidents are better understood." His conclusions were—"All which the author submits goes to prove that in place of attending solely to the pulse, as hitherto, those who administer chloroform should for the future pay equal attention to the respiration of the patient, and in case of accident direct their first attention to it. The corroborative facts as bearing on his former views, as explained at Oxford, which the author wished to submit, were the following:—1st. That from a large number of experiments since published on animals, there is now no reason to doubt that cardiac syncope is a mere accident. The death arises, as carefully observed in such animals, by a form of tetanic fixture of the respiratory muscles in the early stages of the chloroform administration; and the best means of saving the life of such a patient is founded on that view of such accidents, namely, by the immediate adoption of such means for resuscitation as artificial respiration, tracheotomy, with the intermittent 'Faradisation' electric current, to imitate or assist respiration. Secondly. Respiration has its earliest point of departure, not from the phrenic nerve and diaphragm directly, but from certain fibres in the superior laryngeal nerve, which are distributed to the laryngeal mucous membrane, which seem to act in a reflex manner on the diaphragm—stopping its action if the action be too great, as from impure or pungent chloroform acting on the membrane, or possibly from idiosyncracy; as it has been a long time observed, in France especially, that it is dangerous to administer chloroform where irritable larynx exists, or emphysema or other extensive lung disease. That such irritation, under other circumstances, of other branches of the eighth pair, produces permanent closure of the glottis till relieved by tracheotomy—a very formidable remedy no doubt, but one never to be lost sight of in accidents from chloroform."

PRISON DIETARY AND DISCIPLINE.

Mr. EDWARD SMITH, F.R.S. read the first portion of a long report, by himself and Mr. J. R. Milner, "On the influence of prison dietary and punishments upon the bodily functions of prisoners." The Committee remark at some length upon the diversity of rules and of employment in county gaols, and more particularly upon the wide differences in the dietary tables, which renders it "impossible by any method to give an analysis of the amount of nutriment which they supply." It is customary to increase the amount of nutriment according to the duration of the imprisonment, and also to change the dietary from day to day, so that there is considerable daily variation, not only in the kind and quantity of food, but in the amount of nutriment supplied. There is commonly an increased dietary given to those who are sentenced to hard labour; but the modes in which that labour is carried out vary so much, that this is practically valueless. The diet on the convict side of the Wakefield gaol is liberal and uniform. Mr. Milner, who has long and carefully inquired into the subject, and tabulated returns to show the variation of weight in the men during the first twelve months, states as follows:—During the first two months the majority gained weight; in the second bi-monthly period, a loss occurred equal to nearly twice the gain during the first period; in the third, there was still a loss, but not to so great an extent; and the remaining three periods showed a steadily increasing gain. These prisoners have been brought from other gaols after trial and sentence, so that they have passed through that time of anxiety following upon commitment, during which there is reason to think that they fall off very much in condition and health. In a large proportion of cases, Mr. Milner believes that this change is followed by a feeling of relief, and a re-action against previously existing depression; but later on, the continued imprisonment begins to tell, and extra diet becomes necessary. With regard to prison employment, it was found that those who were kept at oakum picking gained nearly 2lb each; of men working at sedentary trades, as tailors, shoemakers, &c. a large per centage gained weight, the average being nearly 1¾lb per man; of carpenters, mechanics, and men employed in winding the yarn, who work standing, a smaller per centage gained weight, and the average was lower; of those employed in weaving canvas, making mats, &c. the work being heavier than in the preceding classes, the majority lost weight. The last class into which the prisoners at Wakefield were divided was that of hand-weavers of coir matting. There is amongst them a greater expenditure of muscular force, and 80 per cent of the men lost weight during their stay, the average loss being nearly 7lb per man. The effect of the various labours would have been more marked but for the extra diet given to the men who were falling off very much in weight. Amongst the men employed in yarn and coir-picking, 26·8 had to be placed on extra diet; in the second group, 26·4 per cent; third, 36·8; fourth, 39·4; while of the matting weavers, 60·1 required additional food. The Committee conclude that the weight of prisoners is much below that of persons of the same age and height in a state of freedom; and that loss of weight during imprisonment is the normal condition of prison discipline. The effect of milk in arresting loss of weight was found most striking, and in a degree far beyond that of the relation of its nutritive elements to the waste of the system. Thus the addition upon Mr. Milner's recommendation of a quarter of a pint of skimmed milk, containing not more than 7 grains of nitrogen, to the daily dietary, caused a reduction in the extra diets from 22·35 per cent. in 1853, to 15·08 in the first nine months of 1854; to 15·27 in 1855, 14·08 in 1856, and to 9·56 in 1857. Experiments showed that the use of tea tended to lessen the weight of prisoners; and consequently that it was unsuited for extra diets. The results of experiments by Dr. Smith in the Coldbath Fields, Wandsworth, New Bailey (Salford), and Canterbury prisons, as to the effects of different kinds of labour are given in the report. The results of these experiments, it is said, enables a comparison to be made between the effects of the modes of punishment at the different gaols, notwithstanding the unaccountable diversity in the use of them; and the results show the great accuracy with which experience enables ordinary officials to regulate their systems of punishment to the full powers of endurance of the prisoners. At Coldbath Fields, they work upon the treadwheel, and rest 15 minutes alternately; but at the New Bailey they are upon the wheel for twelve minutes and rest only four minutes. The actual period of work is therefore 3¾ hours at Coldbath Fields and six hours at the New Bailey; but the labour is lighter at the latter place, and the total effect per day is the same in both prisons. Experiments at the Wandsworth prison as to the effect of crank labour upon the prisoners, the crank

being of superior make on Appold's patent, showed that 3½ hours' labour with 12lb pressure was equal to five hours' with 7lb pressure; and that when the rate of speed was increased beyond the ordinary one, the relative effect of the greater pressure was somewhat higher. In the New Bailey Prison, the cranks are interior to those at Wandsworth. With an estimated medium pressure of 7lb, and a revolution of 36·5, 39·5, and 40 per minute, the amount of inspiration caused was nearly double that at Wandsworth with the 7lb pressure—namely, 1,793 cubic inches of air per minute, with 21½ respirations and 155 pulsations. When the pressure was increased to the nominal one of 9lb, the quantities were nearly 75 per cent higher than with the 12lb pressure at Wandsworth, or 2,105 feet of air and 23½ respirations. Time for time, the effect of crank labour is less than that of the treadwheel; but experience proves that the former is not inferior in severity to the latter, and, in the observation of many, has long been believed to exceed it. It is shown that when the duration of the labour is considered, the effect of the crank at the New Bailey is so great that the treadwheel may be used as a relief from it. In comparing the effect of crank and treadwheel labour, it has been shown that the 12lb crank at Wandsworth and the so-called 7lb crank at the New Bailey are equal time for time, to that of the treadwheel at the New Bailey; and that the effect of the so-called 9lb crank at the New Bailey is nearly equal to that of the treadwheel at Coldbath Fields; but as the time of actual daily labour at the crank is double that on the treadwheel, the whole daily effect of the crank must be double that of the treadwheel. Can it be wondered at that the punishment of the lash and of the dark cell for neglect of work is frequent at the New Bailey, and generally in all the prisons where the ordinary punishments are very severe?

The President thought that a general knowledge of the facts shown by the report must lead to less severe labour punishments in gaols.—Mr. Ker Porter said he had had abundant opportunities for inquiry amongst the convict establishments of Tasmania. There, an ordinary day's work was to break a cubic foot of stone; but that labour, as well as the making of clothes, shoes, &c. had been so classified, that a man could, by attention, do one eighth more work; by general good conduct he could get credited for another eighth; so that a good man might gain a quarter of a day daily, and his imprisonment was proportionately reduced.—Dr. Mowatt said that before he left Lower Bengal, scales of dietary had been in operation five months, which were expressly intended to deter from crime, being little more than half of what would be consumed by persons of the same classes when at liberty. The general result showed that a considerable loss in weight was not inconsistent with a tolerably high standard of health; while in deterring from petty crimes that dietary had operated in the most satisfactory manner. When he asked about the results of labour at the prison in Eastern Bengal, the gaolor's reply was that the gaol was ruined; that the terror of the restrictive dietary was so great, that petty crimes had almost entirely disappeared from the city; and that as there was no prisoners coming in, nothing like remunerative labour could be expected. Of course he did not advocate so low a dietary as would cause a great loss of strength and health.—In reply to a question, Dr. Mowatt said that there were 54 prisons under his charge, of which that at Alipore was one.

ACTION OF LIME ON ANIMAL MATTER.

The President read the following paper "On the action of quicklime on Animal Matter:"—It is commonly believed that quicklime acts powerfully on animal matter, and is capable—to use a popular expression—of consuming it in a very short time. Passages to this effect are to be met with not unfrequently, not only in newspapers, but also even in works of literary repute. In the preceding paper I have given an instance of the kind from "Rose's Biographical Dictionary." Moreover, from the same popular notion, quicklime has, not only of old, but even recently—as recently as the Crimean campaign—been recommended for use in graves, and, we are informed, was employed largely in the interment of the dead in the camp before Sebastopol. In a work published now 22 years ago ("Researches Physiological and Anatomical," vol. 7) I endeavoured to prove, experimentally, that the effect of lime is the opposite of destructive; that it exerts a preservative rather than a destructive influence on the majority of animal and vegetable substances. The trials then described were made in the moist way, as with cream of lime or lime-water, with a great excess of the alkaline earth. I shall now describe some other trials, in which dry lime, unquenched lime, was employed. On the 3d of February, 1859, some insects, one of which was a beetle *(geotrupes stercorarius)*, the ova of the salmon, sugar cane, and portions of some other vegetables were buried in quicklime in powder, and the including vessel was merely covered with paper. Not till the last week of June of this year (1861) was an examination made as to the effects, if any, that were produced. First, of the lime itself. This, for the most part, was found to be converted into carbonate. Next, of the objects included. These were in a shrunken state, such of them, at least, as were capable of shrinking, and were all intensely dry and brittle. Their colour was little altered, nor were the forms of those altered which were capable of resisting shrinking from drying, such as certain leaves, the sugar cane, the beetle; and that little other change than that resulting from desiccation was produced, was proved by subjecting the parts most prone to decomposition to the microscope. The mention of one trial may suffice. A leg of the beetle, after having been steeped a short time in water, was laid open, and what appeared and proved to be the muscular portion of the limb was detached from the horny integument. It exhibited, under a high power, the muscular fasciculi in an unmistakable manner, and the striated fibres were as distinct as in the fresh voluntary muscles. A second trial was made in May of the present year. The subject of this trial was a mouse. It was buried in quicklime in a garden-plot, covered with mould and over all with paper. When taken out, on the 27th June, after forty-four days, most of the lime was still either quicklime or hydrate. The body emitted a slight disagreeable smell, but, with the exception of being shrunk, as if from drying, its form was little altered; its fur was unchanged. A portion of muscle, taken from the thigh, after being moistened, subjected to the microscope, was found to display its striated fibres with perfect distinctness. Are not these results conclusive that lime *per se* has no consuming power over animal matter? And, as regards desiccation and its preservative power witnessed in the instance of muscle—the latter effect depending probably on the former—are not these such as might be expected *a priori*, keeping in mind the powerful attraction lime has for water as shown in its conversion into a hydrate, when as much as 24 per cent of water is solidified? The same dessicating effect of lime, carelessly observed, may have given rise to the popular belief and error already alluded to, and may help to reconcile practice and theory, explaining how quicklime may be usefully employed in interments, when the main object is to check putrefaction and prevent the disengagement of the noxious gases evolved in the putrefaction process. In the work already referred to, after describing the results of the trials made in the moist way on animal and vegetable substances, proving that lime exercises on them a preservative influence, an opinion was offered, founded on the same results, that lime water possesses in a low degree a solvent power. In confirmation, I shall mention an additional trial—one since made—in which the following substances, viz. salmon ova, two or three different kinds of flies, a cricket, sugar cane, and lettuce seed were kept in a stoppered bottle from the 3d January, 1859, to the 1st July, 1861. When examined at the expiration of the time specified, all the different specimens were found, with the exception of the ova of the salmon, little altered in form, rather distended than contracted. A leg of the cricket was laid open, and

what appeared to be muscle was subjected to the microscope. It had all the character of muscle, with the exception of deficiency of striæ, accompanied by an appearance of attenuation. The salmon ova had disappeared, leading to the inference that they had been dissolved. The clear fluid, the lime, having subsided, was of a yellowish colour. A portion of it heated became turbid; it frothed when in ebullition, and evaporated; it yielded a residue proportionally small in quantity. This residue burnt with flame, and left a little coal, which was readily incinerated; the ash in minute quantity was chiefly lime. These results need little comment. They seem to prove that whilst lime tends to prevent putrefaction and fermentation, and thus to preserve from rapid decay animal and vegetable substances, it allows, when moisture is present—that being essential to change—of partial solution, and further, in process of time, when the lime has become saturated with carbonic acid, of disintegration and decomposition of the same substances; and these thus slowly set free may become active and eneeric, that fertilising influence in agriculture, for which they are distinguished.

The other papers were "On the existence and arrangement of the fovea centralis retinæ in the eyes of animals;" by Professor H. Müller; and "On the connection between the functions of respiration and digestion," by Dr. G. Robinson.

Section E.—GEOGRAPHY & ETHNOLOGY.

This section met in the Lecture Hall of the Mechanics' Institution, David-street. In opening the proceedings, John Craufurd, Esq. the president, remarked that it had been usual for his predecessors to make a few observations on the last year's history of the progress of geography. It was unnecessary, however, in consequence of the elaborate and able address given by his friend Sir Roderick Murchison, that he should enlarge upon the subject. With respect to Africa, a good deal had been done and more was in progress. Captain Speke and Captain Grant were endeavouring to discover the source of the Nile—of the river which Dr. Johnson fancied had its source in Abyssinia, distributing plenty, and scattering the harvest of Egypt over half the globe. That was not quite and strictly true; but it did still continue to scatter its harvest over a portion of Europe. We ourselves received from it cotton, corn, and other things. Then there was M. Du Chaillu. He (the President) was not going to say much about him; as he was going to speak for himself by two papers in that section. They had a little to say about Dr. Livingston, and his discoveries upon the Zambesi—of cataracts hardly smaller than the famous ones of Niagara; and also about China, where their discoverers had been very active. In Japan, also, which had been hermetically sealed against this country for centuries, important discoveries had been made, and in Australia, a Scotchman—a countryman of his—had penetrated 2,000 miles. Mr. Macdouall Stewart, a very enterprising person, had made important researches. Instead of dwelling further upon the history of the last year's geography, he had prepared a paper, which, by their leave, he would read, the object of which was to connect the two great branches of geography—ethnology and geography properly so called. He then proceeded to read a paper "On the connection between ethnology and physical geography," of which the following are the principal portions:—It has been the practice of my predecessors to open the meetings of this section by a short address, and I gladly follow their example, choosing for my subject one which I hope you will consider suited to the occasion—the connection between ethnology and physical geography. Man will be found savage, barbarous, or civilised, in proportion to the quality of the race to which he belongs, and to the physical character of the country in which his lot has been cast. Mere intemperance of climate, independent of any other obstacle, is sufficient to prevent man from making any advance towards civilisation, and to hold him permanently in the savage state. The condition of the inhabitants of the Arctic, sub-Arctic, Antarctic, and sub-Antarctic regions are examples. The Esquimaux is the most striking: dwelling where the year consists but of one day and one night, where snow and glaciers are substitutes for the green earth, where no plant yielding food for man will grow, and, save the dog, no domestic animal live, advancement seems to be impossible. The Esquimaux alone can live in such a region, and this only as hunters and fishermen, leading a nomadic life over its vast surface. Under such adverse circumstances, we only wonder at the progress they have made in the arts. Iceland had no aboriginal inhabitants, and was unpeopled until colonised about 1,000 years ago, and this by one of the most highly-gifted races of man, the same which twice-over conquered France and England. Iceland supports cattle, but is incapable of producing any kind of bread corn, and an island equal in extent to Ireland has but 50,000 inhabitants, quiescent but respectable. The great mass of the continent of Australia lies in a temperate region, with well-marked seasons, and the rest in a tropical one. The climate of that portion of it which has been tested is one of the finest in the world, and the land is not encumbered with forest, always so formidable an obstacle to the early advancement of civilisation. Compared to its area, it has but a small extent of coast line, because little indented by gulfs, bays, or inlets, and hence it is wanting in facility of intercommunication. It contained no native plant available to cultivation for human food, and no native animal amenable to domestication, the dog excepted, of small value in such a climate. Under such discouragements, and without communication with strangers, any advancement in civilisation would have been impossible, even had its native inhabitants been of the most highly-gifted races of man. Mentally and physically they are, on the contrary, among the feeblest, consisting of hordes of black, ill-formed, unseemly naked savages, possessed of no arts, except those which enable them to maintain a bare existence from the spontaneous productions of the earth or the water. The discovery of gold has doubled the civilised population, and, with the wool of the sheep, is exported, to the enrichment of the colonists and the world at large, to the yearly value of fifteen millions. Within the last three years we have formed a penal station in the Andaman Islands, which have some good harbours, and, clearing the forest, have introduced with success the cultivated plants and domestic animals of India. In the same southern hemisphere with Australia lies a land of less extent, but of far higher attributes than Australia—New Zealand. The two islands which mainly compose it lie within the same latitudes as Italy, Greece, and the Archipelago. With natural advantages, they possessed, when discovered, no native plant amenable to cultivation, or animal capable of domestication. The inhabitants themselves were emigrants from the intertropical isles of the Pacific, as attested by the identity of their physical form and language with those of these islands. The vast continent of America, temperate, tropical, and equatorial, naturally possesses many of the essential properties requisite for the promotion of a high civilisation. There existed, of course, in America, no nomadic race in the sense in which we apply the term to Tartars and Arabs. Within fifty years, however, of the discovery, some tribes had bred the horse, and now some of the pampas and llanas of South America are infested by robber tribes as dangerous as Bedouins. But the greatest defect of America consisted in the race of man—below the negro of Africa in physical strength, and below the Malay in intelligence. In that portion of America extending from the great chain of lakes to the Gulf of Mexico, where about two centuries and a half ago savage hunters alone wandered, there now exists, planted within that comparatively brief period, an Anglo-Saxon population as numerous as that of the country which colonised it, and of the same rank of civilisation—a fact which attests beyond all question the natural capacity of this region for developing the highest powers of man. This great and prosperous people imitates the country

from whence it sprang in all things—virtues, vices, and follies. In obedience to this example it is at the present moment shedding its blood and wasting its wealth to no rational purpose. Before the white man the red one, in his rudest state, disappears, much in the same manner as do the wild beasts of the forest. Africa, extending over 70 degrees of latitude, although almost an island, has a coast less indented than any other of the great quarters of the globe. Its natural obstacles are hindrances to intercommunication, and therefore to social progress. The races of man which inhabit Africa correspond with the disadvantages of its physical geography. The Egyptians were a home-keeping people, who never left their own country, and who, unable to defend it, have been subdued by a succession of invaders for now thirty ages. Had the Jews, a people far more highly endowed, been sufficiently numerous and powerful, which their poor and limited territory forbade, I am of opinion that, instead of the bondsmen, they would have been the masters of the Egyptians. The tropical and sub-tropical land watered by the Nile is inhabited by a race distinct from the Egyptian, the Nubian, black in complexion, but with well-defined features, and wanting the woolly hair, the acute facial angle, the peculiar odour, and other known characteristics of the true negro. Letters and architectural monuments attest an early and original civilisation of this race distinct from, but inferior to, that of the Egyptians. From the southern limits of the Sahara to the extremity of the Continent, Abyssinia excepted, but the great island of Madagascar included, no race of man exists that has invented letters, built durable architectural monuments, or founded powerful commonwealths. Possessed of great bodily strength and power of supporting toil, the history of the negroes would seem to show that their understandings are not quite in proportion to their physical qualities. Occasionally, even when propitiously situated as to soil and climate, and generally possessed of the most material requisites to civilisation—namely, cultivated plants and domestic animals, it is not easy to account for the inferiority of the negro, not only to the races of Asia, but even to some races of their own Continent, except by attributing it to inferior mental powers. It is this inferiority, combined with eminent capacity for mechanical labour, that has induced the powerful among themselves to make a trade in the weaker, just as other races do in cattle, and which has seduced foreign nations in all ages to engage in the hateful traffic, to abstain from which demands an amount of moral restraint not yet attained by all the nations of Europe, and reached by none of those of Asia. Ten millions of these negroes are now in the New World and its islands, seven millions of whom are slaves, to the great detriment of civilisation, whether as regards the slave or his owner.—(Applause.) The great Malayan and Philippine Archipelagoes afford many striking illustrations of the connection between physical geography and ethnology, and I shall adduce a few examples. The Island of Java, of volcanic formation, has a range of high mountains extending from one end to the other. Its inhabitants, at present about 12,000,000 in number, have immemorially been in possession of letters of their own invention, and their country contains beautiful architectural monuments, while the political institutions of the Javanese prove by their results that they afford no inconsiderable amount of protection to life and property. Opposite to Java, in corresponding latitudes, lies Borneo, of full six times its size, but of physical geography of a very different character. The native inhabitants of Borneo are of the same race of man as those of Java, but written language and architectural monuments are as unknown to them as to the negroes of Africa. Some of them have, however, made a small social progress—domesticate a few animals for food, but none for labour—cultivate a few plants, weave textile fabrics, and manufacture iron; while others are mere wandering savages, all being homicidal and predatory barbarians. The Malayan peninsula and some of the Philippine Islands exhibit a phenomenon unknown in any other part of the world—that of two distinct races of man dwelling, but not intermixing, in one and the same land. These are the Malayan and a diminutive negro, the latter leading an erratic life in the mountains, in as wild a state as that of any tribe of Americans, and the first with more or less civilisation, even possessing a knowledge of letters. The islands of the Pacific, from New Guinea to the Feejee group, are peopled by negroes, always in a lower condition than the brown race which peoples the neighbouring islands, and the greater number of their inhabitants are certainly cannibals. Voyagers have noticed one favourable distinction between these negroes and the brown and more civilised race. They were always found honest, while the fairer people were invariably incorrigible thieves. The brown race in question, proved by identity of physical form and language to be the same from the Sandwich to the New Islands, were found on their discovery (the last-named islands excepted) in a higher state of civilisation than any native people of America, except those inhabiting the plateau of the Andes. This advancement they owed to the possession of such cultivated plants as the yam, the batata, the bread-fruit, the taro or caladium, the cocoanut, and the sugar cane, with such domestic animals as the dog, the hog, and common fowl. But, like the rudest Americans, they had no domestic animals for labour, and were ignorant of iron and every other metal. The Persian race is a peculiar one, and among Asiatics a highly-endowed one, personally and intellectually. For five and twenty centuries, and probably even a longer time, it has been in possession of letters and the skill to erect durable monuments. But the physical geography of the country is certainly a serious impediment to a stable and lasting civilisation, for it not only encourages the invasion, but the permanent settlement within its borders, of pastoral tribes, still retaining their nomadic habits. Throughout Hindostan the race of man is probably, in all essentials, the same, with such varieties only as prevail among Europeans, negroes, and the red man of America. The Hindoos are a black people, of a deeper tint than any other race of man, the African and Oriental negro and Australian excepted. The form of the head and features is European—even of the highest type, the Grecian; but experience teaches us that there must be an essential difference in the quality of the two brains, although too subtle a one for anatomy to detect. There is, in fact, no rational foundation for the extravagant theory which would make Hindoos and Europeans to be of one and the same race, under the absurd and hypothetical designation of Caucasian: twenty centuries of history belie the assertion. Above two thousand years ago the Hindoos were, according to the measure of Asiatic civilisation, a highly advanced people, and possessing the evidences of it in indigenous written language, architectural monuments, and institutions of some skill and great persistency. The highest civilisation of Asia is that of China, the joint result of superiority of race and favourable physical geography. The high mountain chains of China, often rising to the snow level and chiefly lying to the west, are the sources of the great rivers which fertilise spacious alluvial plains, and nourish millions of men. The superiority of Chinese political institutions is proved by its fruits—a progress in the useful arts, and an accumulation of wealth which have never existed in any other Asiatic nation. The Japanese, although resembling in some respects the Chinese, are of much cleaner habits, and must be considered a distinct race of man, both as to physical form and mental capacity. Although the majority of them live in a climate the same as the south of France, they are never fair-complexioned, and never have any hair that varies from a jet black, facts which show plainly enough how little colour depends on climate. The highest civilisation which the Turks ever attained was in Eastern Europe and in Northern India: the highest which the Tartars reached was in China, and the Arabs in Spain. Europe is the quarter of the globe which, through the great advantages of superior physical geography and superior quality of race, has attained the highest measure of civilisation. Its extensive seaboard, caused by deep gulfs and inland seas; its numerous lakes

and rivers; its many islands, with a temperate climate, afford it means of industry, commerce, and intercommunication possessed by no other part of the world. The superiority of its races of man is attested by an experience of three thousand years. The term Europe, however, is but a conventional and not a very well defined one, and the advantages of physical geography and race which I have ascribed to it belong especially to its southern portion, always its only seats of high civilisation. The sterile and oft ice-bound far north has never produced, and seems incapable of producing, a great and powerful civilisation. In its extremest parts, indeed, independent of rigorous climate, we have two inferior races—the Lapps and the Samoeds, in their native locality hardly amenable to civilisation. Yet from the rigorous north has emanated one of the most highly endowed races of man, that which overthrew the huge structure of the Roman empire, which in later times conquered a large portion of France and the whole of Britain, and to which, above all other causes, is owing the vigorous civilisation of modern Europe and of Northern America. The Russian empire is no exception to the rule that the far north has never produced a high and powerful civilisation, for it is not at once powerful and civilised. It is an aggregate of nations and rude tribes, held together by the power of the sword, like the empires of Genghis and of Timur, only far more skilfully administered. The vast superiority of the European over the other races of man, and especially over the precocious, but soon stagnant, races of Asia, need not be insisted on at length. But for the European race China would have been known to the rest of the world only by report, and Japan and the great Indian Archipelago as unknown as America. While the European nations have virtually subdued all America, discovered and conquered a fifth quarter of the globe, Australia, and conquered and occupied a considerable part of Asia, no foreign race can be said to have invaded and permanently settled in Europe. The invasion of the Tartars under Attila were but plundering expeditions on a great scale, and the barbarian was defeated by a Teutonic race in the heart of France. The Saracens held a portion of Spain for eight centuries, never successfully getting further into Europe, and were eventually expelled. Within a century of the death of the man of genius, the Arabian camel driver, who inspired them to foreign enterprise, they had the presumption to venture as far as the centre of France, where by the hammer of God, in the person of a Frankish chief, Charles Martel, they were knocked on the head, as if they had been so many wolves. The races of Asia—and it affords incontestable evidence of incapacity and inaptitude—have borrowed little from Europe. They reject the printing press, obstinately persevering in the slow and expensive manuscript which in Europe impeded the progress of civilisation 500 years ago. They very rarely use the mariner's compass, but steer along the shore or trust to the stars and the monsoons. The European races, have, on the contrary, borrowed freely from every country that had anything good to give. As to the invention of written language and to monuments of a high order, the only parts of Europe which boast of having possessed them are Greece and Italy, which in the march of civilisation had so long preceded all the rest. The nations of Europe, now the foremost in letters, were (the Runic characters excepted, which probably never extended beyond the priesthood) as ignorant of them 2,000 years ago as were the Mexicans when first seen by Europeans. In this respect, as indeed in architecture, they have been but dexterous imitators. This is a striking contrast to the precocious races of Asia, many rude tribes of whom, less civilised than ancient Gauls, Germans, and Britons, have been in possession of alphabets of their own invention from time immemorial. But the most favoured parts of Europe, even those which are now the seats of the highest civilisation, afford, like India and China, examples of civilisation retarded through disadvantages of physical geography, without any proved inferiority of race. Our own island yields two signal instances—Wales and the Highlands of Scotland. Had the whole area of Britain been no better than they, it is quite certain that we could not have been what we are—great, powerful, opulent, and populous. It is only by slow degrees, and the influence and example of a more advanced nation, that a people so circumstanced is brought within the pale of civilisation. The process is, at present, in rapid advancement in the mountains of Wales and Scotland, even to the beneficial extinction of their barbarous, although masculine and forcible, tongues, but it has taken eighteen centuries to bring the Welsh and Highlanders to their present state from that which they were in when Gibbon describes one of them, and the other was probably no better, as consisting of "troops of naked barbarians," who "chased the deer of the forest over cold and lonely heaths, amid gloomy hills and lakes covered with a blue mist."—(Applause.)

Sir John Richardson moved that the excellent paper which had been read by the President should be recommended to be printed. The motion was unanimously passed.—Mr. Hamilton Gray concurred most cordially with the motion, but said that, on two points he had been rather startled. One of these was the statement that the Egyptians were feeble, and that they were a stay-at-home people. They were certainly subdued by an Asiatic race, but, at that time, there seemed every evidence that they were very much divided—that they were not under one strong, powerful government, but were subdivided into several states. They remembered conquests of him who was generally called Sesostris, who over-ran the greater part of Asia; and such examples as that, he thought, exculpated them from the charges of being a feeble stay-at-home race. They certainly were not in the habit of sending forth colonies, as did modern nations. He thought a considerable discussion might be raised with respect to the statement that there was no sort of connection by birth between the Hindoos and the inhabitants of any country in Europe.—Mr. Wilson said, with regard to the Hindoos, he had generally supposed that they were of the same race with Europeans. There were two very strong coincidences with regard to them, which were, the form of the head and the fact of both making use of dialects of the Hindo-Germanic. The difference was not in the form of the head, and, he supposed, not in the texture of the brain, but in the size of the head, which was much larger in the European. — The President said, with reference to the Egyptians, their being a home-keeping people was, he thought, proved by their not liking to quit Egypt, although in bondage. On the other question he said there might be a great resemblance in the form of the skulls, and very little resemblance in the contents. It had always seemed to him to be very great nonsense to fancy that Europeans were descended from black men, or they from us.—It was here suggested by a gentleman in the body of the hall, that the discussion was out of order; and the question then dropped.

Mr. H. Spottiswoode, one of the secretaries, read a paper, by Major General Sir H. C. Rawlinson, K.C.B. "On the direct overland telegraph from Constantinople to Kurrachee." After disclaiming any authority to come forward as a mouthpiece of the Government, the author stated that in 1858 the Turkish government undertook to execute, at its own expense, a line of telegraph from Constantinople to Bussorah, which would form an integral portion of the great line connecting India with Europe. It was foreseen that the line would be convenient both for the requirements of the Turkish trade and the purposes of Turkish government, and would thus benefit the empire; but the money return for the outlay was to be sought in the tariff established for British messages transmitted along the line towards India. The British Government engaged, as soon as there was a fair prospect of the completion of the Turkish undertaking, to carry on the communication from Bussorah to India at its own expense. Some of the officers originally engaged in the undertaking had retired, but three of Lieutenant Holdsworth's *employés*, Mr. Carthew, and

the brothers M'Cullum remained in the country, and, mainly owing to their zeal and skill, the line was now in a working and efficient state the whole way from Constantinople to Bagdad. The Porte had declined to accede to a proposition that Her Majesty's Government should incur half the expenses of the improvements, but had formally engaged to carry out all Colonel Kemball's recommendations for giving greater efficiency to the line at his own expense. A submarine cable from Pera across the Bosphorus having been frequently damaged by the anchors of vessels, it was proposed to suspend a wire from the European to the Asiatic side at the narrowest part of the strait—a distance of not more than 1,000 yards. Precautions had been taken as security against interruption from the Arabs, Kurds, &c. by the line of telegraph being taken from Mardin along the chain of the Masius, where there are located a great body of Jacobite Christians. Colonel Kemball reported favourably of the progress of efforts to conciliate the Arab chiefs living near the outer ranges of the Kurdish mountains. The telegraph consisted of two distinct wires, one of which was reserved for the exclusive use of the British Government; and a convention was about to be signed with the Turkish government for the regulation of the respective shares of the expense to be incurred in keeping the line in working order, for fixing the tariff for the transmission of messages, &c. With reference to the Persian section of the line, attention was being more immediately directed to a continuation of the land-line from Bagdad, through Persia, towards India. Political and physical arguments showed the desirability of taking a northward line, and the author believed that it had been decided to continue the line, in the first instance, directly from Bagdad to Teheran, thence to Khanaki and Kermanshah. From the latter place it would continue to follow the great high road from Babylon eastward. At Teheran the line would join another system of telegraphs, which had been organised in Persia itself. From Bagdad it was proposed to continue the line to Bunder Abbas; and it was almost certain that the Shah would enter cordially into the scheme. The Commissioner in Scinde, the agent for the Government of India, and the Imaum of Muscat, had reported as favourably as could be wished. They were working in what he (Sir Harry) believed, in the present state of oceanic telegraphy, to be the only practicable direction. The PRESIDENT remarked, that if Manchester and Calcutta and Bombay were to be brought into communication in ten or fifteen minutes, as they ought to be, it must be by land, and not by sea. Our oceanic cables had been total failures. We had sunk two or three millions of money, which might as well have been thrown in the form of sovereigns into the Red Sea. Pharaoh had lost his chariots and horsemen; but this country had lost a sum amounting to £50,000 per annum for the next fifty years, — a monstrous sum to spend, and to spend for nothing.— General CHESNEY stated that Captain Lynch, who was out with him at the first forming of the Company, had sent out a vessel (in pieces) to navigate the lower part of the Euphrates, and intended opening a communication with Kurrachee. England required several lines of telegraph, and they should endeavour to secure the one through Persia, as well as that through Arabia. He knew sufficient to believe that the carrying out of the line would be perfectly easy.—Captain CHARLWOOD, R.N. thought the proposed route was as good a one as could possibly be taken, and that the Euphrates Valley was a perfectly feasible line for the telegraph as well as the railway, to be carried on to India. Communication could thus be established between Britain and Hindostan, Calcutta and London, Manchester and Bombay.—A vote of thanks was awarded to the author of the paper, and it was recommended to be printed.

JOHN RAMSAY, Esq. read a paper, entitled "Remarks on the proposal to form a ship canal between East and West Loch Tarbert, in Argyllshire." The length of the proposed canal was 1,600 feet, from high water mark on one side to high water mark on the other. The distance saved by passing through the canal from the Clyde would be fully sixty miles. Eighty years ago the difficulties and dangers arising from the islands near the coast had led to the consideration of a scheme for remedying the evil, and the subject was again agitated in 1846. The probable expense was now estimated at £111,267.—Sir EDWARD BELCHER, R.N. spoke of the advantages of the proposed canal both in a commercial and military point of view.—Sir JOHN RICHARDSON also approved of the scheme; and, on the suggestion of Dr. SIMPSON, the meeting resolved to request the Recommendations Committee to consider the propriety of petitioning Parliament to favour the undertaking.—Sir RODERICK MURCHISON here entered the hall, and at the request of the President, addressed the meeting on the subject, alluding to the great advantages of the proposed canal and its practicability. He expressed his readiness to assist in the forwarding of the views which the meeting had expressed, and was at once informed by the President that he should be placed at the head of the deputation.

The fourth and last paper was read by Mr. SPOTTISWOODE. It was contributed by Louis Kr. Daw, of Christiania, and was "On the ethnology of Finnmark in Norway." It stated that the scanty population of the most northern parts of Germany consisted of the aboriginal Lapps, the Norwegians (immigrants from Norway, &c.), and the Finns, from Finland, each of which divisions had a distinct language. Some of the arts of civilisation had spread into the wilderness, while the Arctic climate was such that any residents must to some extent imitate the native inhabitants. The three languages were much more mixed than was generally believed. The Lapps acknowledged the Finns as individually superior in the arts and trades of civilised life. Competent Christian knowledge was now imparted to the Lapps in their own tongue, and it was contended by some that the Lapp nationality was thereby kept up, and the Norse impeded. The paper contained statistics with respect to the prevalence of the several languages. Mr. Spottiswoode said that, notwithstanding the intimate connection stated to exist between the Lapp and Finn languages, there remained a very curious monument of Finnish antiquity, which indicated, on the other hand, a strong distinction. In the great Finnish mythological poem, "The Kalewala," there were accounts of battles and predatory excursions made by the Finns into the territory of their neighbours the Lapps; and the latter were generally described as hostile in disposition, and inferior in capabilities, to the former.—The PRESIDENT thought that the Norwegians and Finlanders were so closely allied that scarcely any distinction could be draw between them. The Lapps were never found to degenerate when mixed with other nations. The question was, whether there was not some degradation on the part of the Norwegians when mixed with the Lapps.—Sir JOHN RICHARDSON considered that the Lapps had retained much of their vocabulary, but, being driven to the northern part of Norway, had fallen off in civilisation.—After a few remarks from Mr. ROBERT CHAMBERS, a vote of thanks was accorded to the author of the paper, and the proceedings of the day closed about half-past two o'clock.

SECTION F.—ECONOMIC SCIENCE AND STATISTICS.

The proceedings in this section commenced at eleven o'clock; but the Sectional Committee met an hour before that time, and a letter was read from the president of the section, Mr. W. Newmarch, F.R.S. stating that he had been taken seriously unwell, and should be unable to be in his place to deliver the opening address. In the absence of Mr. Newmarch, his place was taken by Lord Monteagle, the vice president of the section. There was a good attendance during the whole of the day, including the following gentlemen:—Colonel Sykes, M.P.; Edward Ashworth, H. Ashworth, Edward Chadwick, Right Hon. J. Napier, Alderman Neild, J. S. Haywood, Dr. Farr, J. E. Rogers, J. S. T. Hammack, Edwin Hill, J.

Shuttleworth, Canon Richson, Mayor of Manchester, Mr. M. Ross, H. Mason (Ashton-under-Lyne), E. Potter, D. Chadwick, W. R. Wood, W. N. Massey, M.P.

Lord MONTEAGLE said he was sorry to be constrained to make an announcement to them which, he was sure, all connected with statistical inquiries would receive with feelings of serious disappointment. This disappointment, he hoped, would be only temporary; but he had to tell them that his excellent friend and able coadjutor, Mr. Newmarch, was so unwell that he could not take the chair, and had wished him, as the vice president of the section, to take his place. Of course, he (Lord Monteagle) was ready to assist in any way he could; but he was sorry that they would be deprived of any preliminary statement; although he hoped that Mr. Newmarch would be able to resume his functions to-morrow. He (Lord Monteagle) would only waste their time by one single sentence in relation to the peculiar duties of the statistical section. They had often been reminded—too often reminded, perhaps, to have any effect on their practice—that their duties were simpler than statisticians sometimes were inclined to admit. It was for other branches to make use of the information acquired by this section. The information they gathered were simply matters of fact. Their duties were simple and modest. They were no less important; but if they were to embrace in their general investigation all the enormous number of subjects which extended from it, their section would become a section which would swallow up all the rest. The noble Chairman then called upon one of the secretaries, who read the minutes of the last meeting of the section at Oxford, which were confirmed.

The CHAIRMAN said that as the first two papers were *in pari materia*, and branches of the same subject, it was proposed to take the discussion upon them together.

Mr. T. BAZLEY, M.P. then proceeded with his paper, entitled, "A Glance at the Cotton Trade." A century ago the population of Manchester was below 30,000, whilst now 350,000 persons reside in and occupy it. Population and wealth have wonderfully increased and ramified to other places, but now in the zenith of prosperity a mysterious hand has written upon our walls the words of caution and of admonition. During the last fifty years upwards of twenty billion pounds weight of cotton from all sources have been consumed in Great Britain, and the value would be probably not less than seven hundred and fifty million pounds sterling, or might equal a sum of the amount of our national debt, the chief supply having been obtained from the United States of America. Upon a fair computation, the import of that material which has so largely employed the capital and labour of this country has yielded a profit of not less than one thousand million pounds sterling to the people of the United Kingdom within that period. The wonder is that so large a supply of cotton could be procured from that one source, the United States, and when we reflect that this country possesses a monopoly of the vast extent of territory found in the whole world capable of producing this raw material, the inference is most palpable, that there has been developed the most successful agricultural industry in the States of America which has been either ever contemplated or realised, whilst in British Colonies and dependencies apathy and neglect have prevailed. If the Legislature had little sympathy with the great industry of Lancashire, the interests of our foreign possessions might have induced our rulers to stimulate productions in them which would have found compensating markets at home. The advocates of large and of independent supplies of raw cotton from all possible sources have never desired Governmental favours, their object having been to promote the removal of repressing obstacles, and to procure, by the aid of a sound colonial policy, at least a fair share, in proportion to the extent of our foreign possessions, of not only cotton, but of every other product which they might more abundantly have yielded. During the last year the consumption of cotton in Great Britain was 85 per cent from the United States, 8 per cent from other foreign sources, and 7 per cent from British territory. The present position of the trade is most precarious and dangerous. Existing stocks and prospective supplies of cotton may enable the mills to be worked into the spring of next year, at moderately full time; but, afterwards, unless supplies be received from the United States, independent sources can only furnish the means of keeping the mills at work little more than one day in the week. With the growth of this industry five millions of our population have become directly and indirectly dependent upon it for their subsistence; and the productiveness of their capital and labour, including the raw material, was for the last year nearly eighty million pounds sterling. Of this large value twenty-five millions of cotton manufactures were absorbed in the consumption of the people of the United Kingdom, and there remained for exportation fifty-five millions. The estimated capital engaged in its fixed and floating investments, is two hundred million pounds. Now, when we contemplate the vast interests involved in this surprising trade, seeing that the people employed and connected with it exceed the population of the kingdom of Belgium, of Holland, and of Portugal; that the national treasury receives from it an amazing sum in aid of the expenses of the State; that a commercial marine of unparalleled magnitude derives support from it; that the comfort and happiness of the labourers employed in it are imperilled by any indications which threaten to disturb its existence and prosperity; and that its suspension, or serious curtailment, would even endanger the general weal; we may well inquire what efforts have been made to sustain the usefulness, prosperity, and permanency of this source of national riches. That the cotton trade should have rested chiefly upon the one supply of the states of America for its very means of existence, every good and every wise man has deplored; but that to produce that supply the portion of the human family which is most defenceless should be held in the degradation of slavery is abhorrent to the feelings of the righteous, of the humane, and of the benevolent. Most effectually to suppress slavery will be to supersede the necessity for the labour of the slave, and if the chiefs of Africa could be induced to cultivate sugar, cotton, and tobacco upon their own soil they need not expel and degrade their labourers. Of the commercial policy of the United States of America censures can scarcely be too severe. In the Northern States protection has prevailed, and the people of the South have been compelled to pay extravagant and monopolist prices for the manufactures produced by their own agricultural labour, and which, in the form of cotton, has been received in this country free from every tax. The North has robbed the South by unjust exactions, and the South has robbed the negro of life and liberty! Why the British manufacturer has tamely submitted to an import tax of 30 per cent upon cotton goods entering the States of America, whilst the raw cotton, the growth of those States, has been received here free from tax or impost, without making an effort to procure supplies of his raw material from free labour with the right to send free exports in exchange, can only be accounted for by the anxiety to possess an apparent immediate benefit at the cost of advantages more enduring, but which could only be regarded as of prospective, or future, possession. Partial and unjust government has at length reaped the fruit of convulsion, and for which unjust policy had sown the seed. The North has taxed for its own protection and advantage the people of the South and their industry; and the South has held in degradation, oppression, and slavery the labourers who have enriched their owners. Mutual wrongs have been committed, and hitherto no just object appears before the world as a cause of the lamentable struggle which is exhausting both of them. But slavery is doomed. A protective system has been fostered in the North, founded very extensively upon the pirated inventions of this country, and by the agency of which our manufactures have been largely excluded from the markets of the States. Even their

very literature has been abstracted from the intellectual faculties of those in their fatherland who have only their cultivated minds and soul-breathing thoughts for their inheritance. In addition to these grave reasons, which mainly affect the morality of the States, this country has been paying a tribute of five million pounds sterling per annum to those States in excess of the price at which cotton could be remuneratively produced and sold. With the convulsion which exists in America, with the adverse commercial policy dominant there, and with the inhuman system of slavery which prevails in the cotton-producing districts, what are the duties which devolve upon our governing and mercantile classes? If by the convulsion of the States we are taught our national, as well as commercial, duties, the lesson will be ultimately beneficial. Whether it has been wise for our Government to see continually increasing the dependence of this great trade upon the one chief supply of its raw material, and that source adverse in interest, and oppressive to its own labour, we can only answer in the negative. With the East and West Indies, with tracts in South, East, and West Africa, and with land in Australia as extensive as Europe, capable of growing cotton from the lowest to the highest qualities, it is a national reproach to us that we have permitted our own fields to be uncultivated, and that our spinners and manufacturers have been driven by necessity to consume the produce of slavery. Lacking the means of communication and of irrigation, the resources of the East Indies remain in much the same dormant condition in which they have been for two thousand years; but brighter prospects are opening in that great dependency; railways are being constructed, canals formed, river navigation improved, and works of irrigation promoted. One great defect is, however, retained with perverse tenacity. The tenure of land is obstructive alike to the rights of individual ownership, and to its effective cultivation. Without doing the slightest wrong to the holders of any land, its equitable transfer might be sanctioned, and a landed proprietary as influential as in our own country might be established. Protection to life and the rights of property, with every other just adjunct of good government, will inevitably lead to prosperity. Small supplies of cotton, as good as that obtained from New Orleans, are now received from India, and the cotton of this vast dependency is certainly improving; but whilst, from a combination of circumstances and causes, the ryot of India is only paid 12s. per acre for his crop of cotton, and the American cultivator can obtain £12, the energy and capability of the former cannot be developed. Supposing efforts to be made commensurate with indicated difficulties, all the common cottons, or seventy-five per cent of the consumption of Great Britain, might be obtained from India in a couple of years. From Egypt the supply of cotton may increase, but there the withering influence of the despot retards its extended cultivation, though the spirited, energetic, and successful enterprise of Mehemet Ali is an example deserving the imitation of better men. He introduced that agricultural industry into his vice royalty, and founded a fountain of wealth whence flow millions of annual income to the advantage of Egypt. For all the finer, higher, and better classes of cotton, from New Orleans, Brazil, and Egyptian to the most beautiful Sea Island, Queensland, in Australia, might quickly afford all requisite supplies. That territory alone, besides sustaining the population of Europe, could easily be made to produce all the cotton now consumed in the world; but so sweeping a change and enlarged production need not be deliberated upon, the facts being only referred to as illustrating the powers of that colony. In seeking from the Government the development of the resources of the colonies, the twofold advantage would arise of which that power would financially be greatly benefited, alike at home and in the colonies. Government must set its Colonial House in order. Land grants for beneficial purposes should be free, facilities afforded for emigration, public works promoted, and prosperity will follow in the train. Capitalists, merchants, and manufacturers, whose investments are largely embarked in the cotton trade, have duties devolving upon them. These bodies are known to have large investments in foreign railways, in the cultivation of sugar and other products, and in many dubious securities; but in the cultivation of the staple raw material of their own pursuits they have not ventured to embark. Last year the cotton trade contributed to capital and labour fifty million pounds sterling, and in the last fifty years the aggregate reward has been one thousand millions. Surely from these treasures might be spared some pittance of capital to free the negro, and to ensure still greater prosperity to industry. Supposing the Government of our country to be willing to make all the preliminary arrangements which will contribute to the security and profit of capital invested in cotton growing, the clear duty of the class referred to will be to enter upon investments with no niggard hand; and, for their encouragement, it may be mentioned that very recently an extensive Louisiana cotton planter has asserted that he could grow cotton at 3d. per lb, which is now worth 9d. per lb in Liverpool, and of course he has had to buy his labourers, and afterwards to sustain them. The confessed profit is 200 per cent, but, in all sobriety of judgment, cotton growing would afford 100 per cent of recompense. Here, then, the governing, the capitalist, the mercantile, and the manufacturing classes have duties in common to perform, and from which none of them should withhold their willing help. Upon this subject the warning voice has been long and often heard, and the present embarrassment in cotton supplies has been anticipated. Having, therefore, been forewarned, may this great and world-benefiting industry be forearmed.

Mr. Alderman Neild then read his paper, which was entitled "An account of the prices of printing cloth from 1812 to 1860."—The two most remarkable years in the table were 1814 and 1825. The first (1814) was soon after the battle of Leipsic, when the continent had been closed to our manufactures for probably 20 years, and when it was believed (to quote a saying of the time) "there would not be a piece for every village." With extravagant notions like these, there was no wonder that the excitement became intense, and 80 reed grey printing cloth rose from 25s. per piece to 49s. and one style of prints which were produced by his own concern, known in the trade by the term "single coloured plates," rose from 44s. 4d. to 63s. or from 19d. per yard to 2s. 3d. a striking instance of the change which had taken place in the value of this article, from the period named to the present time. They were now selling a much superior article of the same class for 11s. or about 4⅝d. per yard; by superior, he meant so much better, both in design and execution, and brilliancy of colour, that if the production of 1814 were placed side by side with the production of 1860 at two-thirds the price, the piece of 1860 would be taken, and the one of 1814 left. It must be borne in mind that there was an item in the cost of the piece of 1814, from which we are now happily free, namely, an excise duty of 5s. 10½d. per piece, which upon the present value of the print, was about 53 per cent. This tax was repealed in 1831. The other year named, 1825, would be remembered by many as one of extraordinary speculation and excitement, principally in raw cotton. The manufacturer endeavoured to keep pace by advancing his cloth, and ⅞-72 reed printing cloth rose, in that year, from about 13s. 6d. to 19s. This, however, had the effect of almost putting a stop to the demand; and he did not remember an instance in which the retail trade more steadily kept aloof from purchasing. Quite different was the case in 1814, on which occasion (for a time at least) it was thought that circumstances justified the excitement. During this time of great speculation, sales, except to a very limited extent, were out of the question. The result was, a great accumulation of stocks. The usury laws were then in force, and in consequence of the very high rate of money, manufacturers were driven to most terrible sacrifices upon their stocks, and he seldom or never remembered so much suffering amongst them. At length, prices began to give way; and the cloth in question very soon fell from 19s. to 13s. 6d. about which price

it had steadily range… for about two years previous to the speculation; consequently, many then thought the price a safe one, but in a very short time it fell to 10s. or nearly 50 per cent from the highest point. This fall occurred in a period of about nine months. In 1848, this same cloth touched the very low point of 4s. 6d.; its present value being 6s. 10d. In 1816 the price of 80 reed cloth was 29s. This period was one of depression rather than excitement; whilst as a remarkable instance of the change in the price of an article, differing only slightly in value, it fell in 1848 to 4s. 6d. The causes which have operated to produce these changes, might be named under such general heads as the following, viz.; reduction in the price of the raw material—improved machinery—improved training of the hands employed—and the enormous increase of demand, which has enabled the manufacturer to diminish the cost per piece on his fixed expenses, by turning off a greater number of pieces from the same machinery. Lowness of price, again, has been continually stimulating the demand. He had thus endeavoured to show the history of the fluctuations in the price of one article for a period of about half a century, forty-three years of which had been merely the record of his own purchases.

Colonel SYKES said that some time ago he published in the papers of the Asiatic Society an account of the sale and transfer of land in India. Mr. Bazley evidently seemed to think that land in India stood on a different footing with that of other civilised countries. This was not the case. Land in India was held by the people there who paid taxes to the government, and as long as they paid their taxes the government did not interfere with them. No doubt in Madras, where the government interfered professedly to benefit the tenant, the result had been considerable oppression and plunder. The land tax was paid by the people of India, and the government said to them, "Your land tax is so much. As long as you pay this, you can enjoy your estate; but if you don't pay we shall sell your estates." That had, unhappily, been done in many instances, and this had no doubt led to the impression that there was no right of land in India. The Government had fixed the land tax for 30 years at one half what it was under the native princes; and the farmer there might cultivate cotton, flax, oil seeds, sugar, or indigo, and, in fact, lay out his money just as he liked. With regard to the prospect of a supply of cotton from India, that country had produced cotton of various qualities for 2,000 years. Mr. Bazley himself had estimated cotton grown in Hyderabad at 1s. 7d. per pound; and this was grown on land that was not irrigated. India had been the indigenous soil for cotton from all ages; and of so fine a texture could it be produced, that he had the translation of a sermon preached 500 years before Christ, in which the preacher prohibited women from wearing cotton cloth, because it was so transparent. Indian cotton was wanted in this country. How could they get it? The same question had been asked for twenty-five years. They could not compel the farmer to cultivate cotton if he could gain more by sugar. It was a mere question of price; and the moment they could show the farmer the advantage of growing cotton he would do so. No doubt it was right that the Government should make roads, and also give their influence in connection with this very desirable staple; but the Government of England might as well have said to an English farmer, during the famine in Ireland, "You shall grow nothing but potatoes," as say now to an Indian farmer, "You shall grow nothing but cotton." He repeated again, it was a mere question of price. It was a different thing with the waste lands of India. There were 1,470,000 square miles of land in India, one third of which was waste land, consisting of forest and, he was sorry to say, a great deal of desert; and there was also what was called the "rumna," the waste land in the neighbourhood of villages, but these were used as common pasturage by the villagers, and were jealously guarded by the municipalities who governed those villages. In talking of India, they must recollect they were not talking of a mere handful of people; but of 21 different nations and languages. He entirely concurred that the waste lands should be sold out-and-out. They were now being granted on what was almost a fee simple. But, then, they must recollect that this was mere waste land, without capital or speculators. He believed if the work of the Cotton Supply Association was persevered in it would succeed, and be highly advantageous. But why limit themselves to India? There was already a nucleus of a supply from Africa formed at Abbeokuta, by the African Aid Society, under the superintendence of Lord Alfred Churchill. By pecuniary aid to that Society they might do very much good. Queensland and the West Indies were also open to their capital and enterprise.

Mr. H. ASHWORTH congratulated the meeting in having amongst them a gentleman like Colonel Sykes, who was willing to become an apologist for the Government.—[Colonel SYKES: I am not an apologist.]—They all knew that in Manchester they were on the eve of dividing the last bale of cotton from the United States, and of a time when a deserving and industrious population might be on the verge of starvation. The gallant Colonel said that they might have any amount of cotton from India if they would give the price for it. When they considered the element of price, it must be recollected that although the Government of India had so large a tract of land, and the people were capable of producing an almost indefinite supply of cotton, the United States could produce a cheaper and better article. In England, the landowners for a long time let their farms to tenants from year to year, and kept the tenants in good temper by fair promises, and by sundry sugar-plums given at agricultural societies, and by giving a man who had worked 40 or 50 years without troubling the parish, just enough to buy him a burial suit.—(Laughter.) This system had been broken down in England; and now, if a man invested his capital in the cultivation of the soil, he must have a proper tenure of the land. The same must be done in India, and the owner or cultivator of the soil must also have proper protection from the Government of the country.—(Hear, hear.)

Mr. W. M. TARTT asked whether, in the case of the land held by families in India, as described by Colonel Sykes, it could be sold or transferred by them. He asked the question because he knew that in the Neapolitan states families held land from generation to generation on the payment of certain claims, but they had not the power of selling.

Colonel SYKES said he had proofs of families being able to sell portions of land with the consent of the municipality. Colonel Sykes was proceeding to reply to the remarks of Mr. H. Ashworth, when Professor Rogers rose to order, and said that the discussion would be interminably prolonged if gentlemen were allowed to speak more than once.

Mr. M. ROSS said it was well known to many gentlemen that Colonel Sykes had been connected with the past and was connected with the present Government of India; and as one of the sleeping partners in a concern which had been sadly neglected, but which concern had recently had infused into it fresh capital and fresh blood, while he was not willing to confess the faults of the old concern, he was not over anxious to give full co-operation to the efforts of the new one. — (Laughter.) Colonel Sykes must have thought that they could swallow anything, or that they were utterly blind and deaf to what had taken place within the last twenty years, when he wished them to suppose that the land in India was not held on a different footing to that of any other country. They had had a letter from the Governor General of India within the last ten days in direct opposition to that statement. He put it to Colonel Sykes whether he had ever heard of a farm for sale in fee simple in perpetuity? (Col. SYKES: Never.) He thanked Col. Sykes, also, for the admission that it was the duty of the government to make roads; but how long had they obstructed the making of railways by demanding unnatural terms? It was only since the new firm commenced that anything was done in the right direction. If

they had done what they were now doing, from continual pressure from without, twenty years ago, this discussion would have been wholly unnecessary. (Hear, hear.)

Mr. E. ASHWORTH, as vice-chairman of the Cotton Supply Association, said he felt bound to allude to two fallacies in Col. Sykes's remarks. They were told that the Government was never asked by any official body in England to interfere in the land titles of the people who held those titles. In a recent document, the Indian Government said that they were asked to interfere in intricate titles; but there was a rule that no land should be transferred without the leave of the Government. What they complained of was, that Government threw obstacles in the way of the transfer of land. The second fallacy was, that they asked the Government to cultivate cotton. What they complained of was, that the Government stood in the way of the native ryot, and offered no encouragement for the investment of capital.

Mr. S. GREGSON, M.P. said it was not worth badgering as to whether the charges brought by the Government against the manufacturers, or by the manufacturers against the Government, were correct. He believed there had been admissions on both sides. A great crisis had arrived. If both parties were in earnest, as there was no doubt of the capabilities of India, he thought every difficulty might be removed.—(Hear, hear.)

The Right Hon. J. NAPIER said, if he understood Mr. Bazley rightly, he pointed out the great advantages of a supply of cotton from India, but said that capitalists in England could not be expected to invest their money there without a perfectly secure tenure. It was no answer to say that the old families in India held their own land. Capitalists came forward and said that they were ready, if they could obtain the same security as they did in England, to purchase land. Had they got it? If not, why not? The question was one properly belonging to economic science; and it should be pressed upon the attention of the Government.

Another gentleman having spoken on the subject,

Lord MONTEAGLE said he thought the discussion of the question ought now to have no further reference to the past except as an auxiliary to their instruction in the future. Let by-gones be by-gones. If they did not abstain from mutual recriminations, no good result would accrue. What had been stated showed plainly that a great opportunity was before them. He happened to be in office at the Exchequer at the time when a very much disputed and vexed question bearing upon the same principle was brought under consideration. It was the question of East Indian sugar. There was as much talk and as much bitterness of feeling with respect to East India and West India sugar as there was now with respect to the growth of cotton and the tenure of land. It so happened that an opportunity came; it was like the present opportunity; and he proposed to Parliament the entire and perfect equalisation of those duties. He believed that East India sugar at that time was as ineligible in the market as East India cotton was now; it was made of worse material. That measure was carried, and they would find now that, by relying on sound economical principles, East India sugar had risen in quality infinitely higher than ever was dreamed of. He said, "Try the same principles; remove obstacles; don't let the Indian government at home or in India say that everything must be done by individuals, and let not individuals say that everything must be done by the Indian government. Both must take their share." But in relation to the cotton supply from India, or anything relating thereto, he must say that there were greater claims upon the government than in any other case the history of the world had ever shown; because the great source of revenue derived for the support of the government came from the land. They spoke of the land tax in England. It was a mere "flea-bite." But the land tax in India was the principal source of financial supply in that country; and, therefore, as a matter, not only of duty, but of sound policy, every obstacle which stood in the way of the productiveness of the land in India should be removed. It had been said that the mischiefs they had to deplore must cease. The case was not that what was good and right would not ultimately be done. Truth was great and would prevail; but the difficulty was, might it not prevail too late?—(Hear, hear.) They had a great opportunity before them. Let them collect and bring forward as many facts as possible. Let them not waste their time in finding fault with one another; but discover what was best to be done under the circumstances and do it.—(Cheers.)

A vote of thanks was passed to Mr. Bazley and to Alderman Neild for their papers.

MANUFACTURE OF EMBROIDERY.

Dr. J. STRANG read a paper "On the altered condition of the embroidered muslin manufacture of Scotland and Ireland since 1857." He enlarged upon the advantages of this particular occupation in encouraging artistic skill and taste, and in affording occupation for females at their own homes. He deplored the capricious fickleness of female fashion, which had led to a great decline, and said it was to be hoped that so long as the tasteful designer continued to dream after some new shape or pattern—so long as the unwearied energy of the manufacturer was exerted to create new articles of utility, and the restless activity of the merchant was spent on discovering some new market for their disposal, the future of the muslin embroidery manufacture would ere long become, as heretofore, a pleasing and profitable occupation during the intervals of field labour and domestic duties to at least as great a number as it formerly did of the industrious females of Scotland and Ireland.

BLEACHING.

Mr. HENRY ASHWORTH also read a paper on bleaching. Having traced the art of bleaching from its commencement to the present time, and described the present process in an interesting manner, Mr. Ashworth continued to say that by an art which half a century ago was almost unknown, and by the agency of our coal as fuel, we have succeeded in converting certain products which we dig from under our feet, such as salt, pyrites, and lime, into one of the most important branches of manufacturing chemistry. These discoveries in chemistry may appear extraordinary, although they are not more important in the economy of bleaching than are the mechanical arrangements which have superseded the exposure of labourers, in all states of the weather, to the accustomed drudgery of the "crofters" of old. The "crofters," of whom he had spoken, bore the appearance of remarkably strong men; their working dress was of thick white flannel, called "gladding;" the cut of the coat was peculiar, having a loose, open appearance, and a low, flat collar, on which the shirt collar usually rested. They had their necks uncovered; and, their employment being so much exposed to moisture, they seldom wore stockings. Altogether, they assumed a bearing of unconcern about the state of the weather, and were quite regardless of the splashing of water. Their employment consisted mainly in the handling of wet cloth, and in removing it, either by hand or by wheelbarrows, from one operation to another. Perhaps the most distressing part of their labour was that of carrying upon their shoulders a pile of wet cloth, rising to some height above the head, which they conveyed to some considerable distance in the fields, and spread upon the grass. In the severity of the winter season there would be drippings from the cloth, forming icicles, which would be adhering to the skirts of their clothing. It has been through a succession of mechanical inventions that these laborious operations have been dispensed with, and one after another they have been handed over to the power of the steam engine. The result has been that the time required for the operation of bleaching is now about as many days as formerly it required weeks to accomplish. Honour to British genius that these advantages have been derived to our country. The general public will no doubt feel curious to ascertain whether any, and what, proportion of the money saving thus effected has reached the consumer; some other portion of the public will inquire

in what extent the advantages thus achieved by science and art have been shared by the operative class employed? It is not expected that much concern will be manifested about the interests of the proprietor, and it is not unreasonable to suppose that a still more minute inquiry will be raised about the "human machine," more especially, whether, during the progress of these advances in manufacturing art, the material, moral, and intellectual condition of the working class has been made to keep pace with all these improved manipulations, which, amidst the struggle of changes, have destroyed the character of many employments, but have greatly increased the whole number of persons employed? These inquiries it would be his endeavour to satisfy. The advantages shared by the consumer will easily be reckoned. He had before him a printed card, or list of prices for bleaching, issued by a leading firm in the year 1803. At that time the charge for bleaching a well-known description of cloth was 7s. 6d. for a piece of 28 yards, and it is now 6d. The case of the labourers employed in bleaching 60 or 70 years ago was, as before stated, a very harassing one—they suffered severely from exposure to wet and cold, and, as a consequence, from rheumatism and asthma. The earnings of a "crofter" would be from 10s. to 15s. per week. Upon wages so scanty, and with some uncertainty of employment, their mode of living was necessarily inexpensive. Oatmeal was the staple commodity of their food. They used it as porridge; their bread was of oatmeal, either in leavened oat cakes or baked in the form of a loaf called jannock, which is said to have been introduced by the refugee Flemings; and animal food with the exception of bacon, was seldon found at the working man's table. Nowadays, the workmen in bleach works perform all their work indoors, and are therefore no longer exposed to the coldness and moisture of the former period. Their wages are increased in a proportion which cannot easily be estimated, and their employment is one of great regularity. They have nearly ceased to consume oatmeal; jannock is unheard of; oat cakes are seldom seen; and their tables are now daily spread with wheaten bread, animal food from the shambles, and all the other articles which usually enter into the consumption of families in the other grades in life. The social condition of the operative bleacher of early times cannot easily be separated from the rest of the working population of that day, neither could they now be described in any other manner than that which would apply to the operatives around them in other pursuits. He might refer to their modes of pleasure-taking as affording in itself a very appreciable indication of the past and present The amusements which formerly prevailed were rude and boisterous—now they are more refined and intellectual. Bull-baiting, bear-baiting, and cock-fighting were amongst the common amusements of the day, especially at the wakes and fairs. The game of foot-ball was a very favourite one, so much so that the people of one place would make selection of their combatants and have them pitched against those of some other place, and these would contend in very ardent strife for the renown of mastery. Indeed, so very popular was this game that a match at football was upon one day in the year tolerated by the inhabitants in the streets of Bolton. The whole of this is now given up. The game of cricket is becoming a popular one, and others equally harmless in their character are being introduced. Seventy years ago, Sunday schools had made but slight progress. There were but few persons who could read, still fewer who could write; and when anyone received a letter, he had to carry it away, perhaps a good many miles, to find a scholar who could read it. At the present time, Sunday schools abound, day schools are numerous, and the affair of carrying away a letter in search of a scholar may now with much complacency be put down as among the reminiscences of seventy years ago.

In proposing a vote of thanks to Mr. H. Ashworth and Dr. Strang, Mr. E. CHADWICK referred to the statistics of mortality and to the state of education as somewhat taking from the bright colouring of the picture drawn by Mr. H. Ashworth as to the condition of the people. On education he had some title to speak, as his grandfather was the founder of the first Sunday school in that county. Whatever may have been the progress of education in quality, if they looked at the list of marriages they would find that 33 per cent of the males and 40 per cent of the females were "marks" men and women—that was, they signed their names with a cross.—Mr. C. S. BRACEBRIDGE seconded the resolution.—Mr. RAPER attributed the number of "marksmen" in marriages to the haste of the registrar when great numbers were married at once, rather than to any defect in education. The case would be different if people were married singly—(laughter)—there would be more leisure for the signatures being taken than where they were married in large numbers.—In reply to the vote of thanks, Mr. ASHWORTH said that where the population consisted of so many immigrants, who brought with them aged people who only came to die, it was difficult to decide on the merits of the tests applied either to mortality or education.

PRICES IN ENGLAND IN 1582—1620.

Professor ROGERS read an able paper on this subject, with a view of supplying some details, and showing the practicability of obtaining others, to establish a history of prices during certain epochs in the entire period of modern European history. A considerable amount of valuable material was to be found in the account books of the domestic expenditure in noble and wealthy families. Some of them had long been before the world. Fleetwood collected prices with a view to determine that the fellow of a college could conscientiously hold his fellowship, though he might possess the exact sum in private income which, according to the statutes of his college, determined the vacation of his emolument. Bloomfield collected facts in his laborious history of Norfolk. So they had the Northumberland Household Book 1503-1513, edited by Bishop Percy; books containing an account of the expenditure of the Earls of Derby, and of Lord Chief Justice Coke. To these must be added the most copious, continuous, and important of all these records, the Shuttleworth accounts published by the Chetham Society. He had hopes that the value which attached to such a publication as that of the Shuttleworth accounts would induce the owners of similar ones to put them into the hands of editors as learned and diligent as Messrs. Raine and Harland. Professor Rogers proceeded to point out the effect of the American discoveries on prices during the period indicated, deriving his facts mainly from the records of monastic institutions. Mr. SWALLOW called Professor Rogers's attention to some interesting facts to be gleaned on the subject in the parish of Ashley, near Market Drayton; and Mr. HAMILTON GREY said that a repertory of prices for labour and of money paid to different tradesmen ranging from 1580 to 1600, was to be found in the muniment chamber of Hardwicke Hall, built by Elizabeth of Hardwicke. Her Ladyship kept minutely an account of the wages paid to carpenters, and of every shilling paid by her during the course of her life. One of the items which frequently occurred whilst Her Ladyship was in London was, "A bottle of claret to entertain Mr. So-and-so."—(Laughter.) He wished the Duke of Devonshire could be prevailed upon to publish it.—A vote of thanks having been passed to Professor Rogers, the section adjourned.

SECTION G.—MECHANICAL SCIENCE.

The proceedings of this section were opened at the Swedenborgian Schoolrooms, Peter-street, at eleven o'clock. The President of the section, Mr. J. F. Bateman, C.E. F.R.S. took the chair. Amongst those present were — Mr. J. Scott Russell, F.R.S. Professor Willis, Rev. Dr. Robinson, F.R.S. of Armagh, Mr. T. Webster, F.R.S. Mr. J. G. Appold, F.R.S. Mr. Richard Roberts, C.E. Mr. W. B. Robinson, Mr. J. C. Dennis, F.R.A.S. Captain Blakely, R.A. Mr. P. L. Le Neve Foster, M.A. Mr. Henry Wright, the Mayor of Manchester (M. Curtis, Esq.), Admiral Sir Edmund Belcher, &c.

The PRESIDENT, who was received with applause, delivered the following opening address:—It has for some years been the custom of those who have filled the position which by the favour of the Association I have now the honour to hold, to address a few words at the commencement of the session, for the purpose of affording information to strangers and to those who may be recently admitted into the Society, as to the objects of the meeting, and the mode of conducting the business of the section; and also for the purpose of bringing under the notice of the members any novel, prominent, or interesting subject which is deserving of their attention, and upon which it would appear to be for the good of the Association and for the promotion of science that discussion should be invited. To those who favour us with their attendance for the first time, it may be sufficient to say that the object of the section is the promotion of mechanical science in a wide sense, for to this section also stand referred all questions of civil engineering, which, although they may in themselves be only remotely connected with mechanics, yet depend for their successful issue upon the proper application of mechanical knowledge. Indeed, it would be difficult to say to what material pursuit in life mechanical skill is not of primary importance. All papers which have been previously submitted to the Committee, and approved by that body as proper papers to be read, or as affording fit subjects of discussion, will be read by the authors or by the secretary of the section. Discussion will then be invited, and it is hoped that all those who are capable of throwing any light on doubtful points, or aiding the advance of knowledge by any information they possess, will give us the advantage of their suggestions or their practical experience. At the same time, as our hours are limited, and as we hope the papers will be numerous and of much interest, we must endeavour to avoid all unprofitable discussion, and as far as possible place all papers on similar or kindred subjects into distinct groups, so as to economise the time devoted to subsequent discussion. It is now 19 years since I had the privilege of becoming a member of this Association, and of acting as one of the secretaries of this section at its former meeting in Manchester. During that period there was a time of apathy, when for some years it seemed doubtful whether the section could keep itself alive, and when I believe the propriety of putting an end to it was seriously debated. Since the meeting at Hull, however, when our excellent president presided over the interests of this section, it has pursued a more vigorous career, and as there is no section of which the practical importance can be more fully admitted, so I trust the exertions of its supporters will impart such interest to its proceedings as will render it as attractive to the real promoters of science as any section of the Association, and as useful in its results. In Manchester especially this section should be well supported, for in this district have been or have resided some of the most distinguished projectors and inventors of the age—men whose ingenuity and labours have conferred incalculable benefit upon the world—such men as the Duke of Bridgewater, Sir Richard Arkwright, and Samuel Crompton, in days not long gone by, and whose places have been well filled by the inventors and mechanics of our own time. Amongst the questions which have recently attracted popular attention, and which are specially deserving of the consideration of the mechanical men of the day are the improvements which are taking place in the construction of artillery, and in the antagonistic work of protecting the vessels of our navy from the terrible destruction to which they are exposed by the superior power and longer range of the guns which can now be brought to bear against them. It seems, at first sight, almost a matter of regret that our inventive faculties should be strained to the utmost to produce the most deadly weapon, and to ensure the most certain and extensive destruction of human life; but, as there is no axiom more true than that of a late great commander, that "the best security for peace is to be well prepared for war," and as it may be reasonably assumed that the highest state of prosperity and civilisation in the present state of the world is that in which wealth and mechanical skill will be most highly developed, and that these advantages will always secure superiority to the most civilised community, it may be honestly presumed that the more terrible we make our means of destruction, the more seldom shall we have occasion to use them. In this way it may be hoped that even these, as well as all other mechanical inventions may, under the blessing of God, tend to the maintenance of peace, and to the progress of civilisation and humanity. Content to leave the result to higher powers, let us, in whatever way we employ that wonderful faculty of invention, and the powers of mind which God has given us, endeavour to imitate the amazing mechanical contrivances which He has exhibited in every form of nature, and in the minutest as well as the greatest, of His works. On the subject of gunnery and ship armour, we shall be fortunate in having the presence of many of those who have taken leading parts in their construction or improvement, and in the experimental and scientific investigation of these important questions; but I am sure that the section will join me in the expression of deep regret that one amongst that number, second to none in mechanical skill, in successful results, and in indomitable perseverance, no less a man than that distinguished Manchester citizen, Mr. Whitworth, is prevented being here by serious illness. I trust it is only temporary, and that he will yet live many years to enjoy the profits and honours of successful enterprise. In the Model-room, however, will be found one of his powerful and beautiful pieces of ordnance, and an armour plate, four inches in thickness, pierced by the bolt discharged from his 12-pounder cannon. We are also to be favoured with some of the plates and other illustrations of the recent highly-important experiments at Shoeburynesss, which, I trust, will be accompanied by explanations by our president, or by other members of the Association who have taken part in conducting these experiments. The respective merits of the various inventions which are now exciting attention, and the various modes of constructing ordnance and ship armour will thus, I hope, be brought fairly and fully before the section. The anxious attention of those most interested in the management of railways, was, during the late very severe winter, when the thermometer fell in some places 10° or 12° below zero, unexpectedly directed to the sudden and numerous fractures in the tires of the wheels of the carriages and engines. Indeed, for some weeks travelling by railway was exceedingly unsafe, and the speed of the trains had to be generally and materially reduced. The cause of these fractures, and the best mode of preventing similar occurrences in severe cold are matters of public importance, and fit subjects for notice and discussion in this section. But serious as were the dangers resulting from the intense cold of last winter, they are as nothing to those which appear to attend the benefit of railway travelling by the excursion trains of the summer. Within the last few days we have been horrified by the accounts of two of the most disastrous accidents which have occurred in this country. As to the cause of one of these we have as yet but vague particulars. The other seems to have resulted from a failure in the working of signals, and from a want of perfect understanding between two signalmen. The prevention of railway accidents is a fruitful subject of discussion, and one to which this section may very usefully devote a portion of its time and attention. We have amongst us many members connected with the mechanical arrangements and the management of railways, and valuable practical suggestions emanating from such a body would be acceptable to the public at the present time. Another subject which has recently attracted attention by the terrible and disastrous conflagration in Tooley-street, in London, is the extinction of fire. The powers which now exist for this purpose, with the methods which are adopted, would form useful topics for consideration, and such notices as will illustrate the most approved methods of prevention—

whether by the adoption of plans of fire-proof construction, or by the judicious application of water—could not fail to be both interesting and instructive. In a report written in 1844, by Mr. Samuel Holme, on the prevention of fire in Liverpool, he gave an estimate of the loss which had been occasioned by fires in half a century, amounting to the sum of £1,250,000, and the loss of upwards of 60 lives. The frequent recurrence of fire was sufficient to give Liverpool an unenviable notoriety; but the single fire in Tooley-street which occurred last June nearly doubled the total loss which had occurred in Liverpool during a period of fifty years. Manchester has fortunately been comparatively exempt from calamities of this nature. I find from the returns prepared by Mr. Rose, the superintendent of the fire brigade, that from 1848 to 1860 inclusive, the total amount of property destroyed has been £854,373, and the total amount of property saved has been £5,900,364, being an average salvage of £453,874, and an average destruction of property amounting to £65,721. There are peculiarities in the means adopted in Manchester for the prevention of fires which are deserving of attention. Probably this subject will be alluded to in the course of the meeting; but, as having been responsible for the arrangements which were adopted when the whole piping of the city was re-organised and extended, on the introduction of the new supply from Longdendale, I may perhaps be allowed to say a few words on the subject. We had an ample supply of water, and considerable pressure varying from 100 to 200 feet in the centre of the city and in those parts in which the most valuable descriptions of property were generally to be found. With these advantages it was my object to get rid of the old clumsy wooden contrivance called a "fire plug," which was a disgrace to the mechanical skill of the age, and to do away as far as possible with the use of fire engines. This we have to a great extent been enabled to do, both in Manchester and elsewhere. In those parts of the city in which protection against fire was most important, the dimensions and arrangements of the pipes were determined with special reference to these circumstances. In place of the old wood plug, a simple fire cock, by which almost instantaneous communication could be made with the water in the pipe, and to which a hose and jet could be attached, was adopted, and the fire engines were rather used as carriages or omnibuses for the conveyance of the firemen and their implements, than for actual use at a fire. Nearly every valuable block of building in Manchester is commanded by at least a dozen fire cocks within 100 yards. As an illustration of the advantage derived, I may quote from a report on the re-arrangement of the piping in the city of Glasgow, in which the same principles have been adopted. "As an illustration of this I may mention two fires which have occurred in Manchester, one immediately before the introduction of the fresh supply of water there and the adoption of the improved fire cock, and the other after the new system had been perfected. The first was a large warehouse in Piccadilly, the property of Messrs. Wood and Westhead, which was burned to the ground with all its contents, the damage done being about £90,000. There were nine fire engines on the ground at work and one idle, and in addition, four jets from fire cocks of an old construction. Upwards of 500 persons were employed in working the fire engines. The other was the warehouse of Messrs. Alexander Henry and Co. in the immediate neighbourhood of the first. Mr. Rose, the superintendent of the fire brigade, informs me that there were goods in the warehouse of the value of £145,000, and that when he arrived at the building the fire was blazing out of 18 windows. In less than 20 minutes 11 jets were at work from fire cocks in the streets—not more than 50 men were employed, and the damage done was only £35,000. £110,000 were saved." The great object to be arrived at is the immediate application of a sufficient quantity of water at the commencement of a fire; when it has once attained a powerful ascendancy, scarcely any water can extinguish it, and all that can be done by the firemen is to prevent its extending to adjoining property. It should also be borne in mind that water cannot be thrown with effect either by the pressure of gravitation or by the force pump of the fire engine beyond a limited height, which is practically under one hundred feet. The question of the patent laws, and their bearing on the encouragement or discouragement of mechanical invention will be prominently brought before the society, and I doubt not very ably discussed by some of our most eminent men, who have specially considered the effect of protection. It is proposed to devote, if necessary, the whole of Friday to this important and interesting question, and I must invite the attendance of those who will either take part in the discussion, or be interested in listening to the various arguments which may be adduced in favour of the respective opinions which may be advanced on the subject. Many other matters of interest and importance will I hope be brought before the section, and in the discussions which may arise on steam, on the best form of vessels, on the ventilation of coal mines, navigation, and the other subjects to which the papers before us promise to draw our attention, I trust we may all derive instruction and advantage, and find that the bringing together of people from all parts of the country for friendly discussion, and for the mutual interchange of knowledge, fully carries out the object of the Association by the advancement of science. (Applause.)

Mr. James Oldham read a paper, prepared at the request of the Association, in which he traced the history of the construction of the various docks at Hull, showing the necessity of increased dock accommodation, from the increase of steam navigation, and explained the nature of the proposed dock extensions to the westward along the shore, and upon land at present occupied as pasture. He mentioned, in the course of this paper, an interesting fact which had come under his notice with regard to the tides of Hull, namely, that whenever the tide reached what was called the sixteen feet mark, it was exactly three hours in rising to high water, and three hours in sinking again to the 16 feet mark, no matter whether the tides were spring tides or neap tides.—The President remarked that this was a most interesting phenomenon, and it was important to know whether the same thing had been observed in other parts of the country.—In reply to a question, Mr. Oldham stated that the highest spring tides were 29 feet above the sill of the dock, and the lowest neap tides were from 17 to 18 feet above the sill of the dock—a difference of 11 feet.—Mr. Scott Russell said he was rather puzzled to find out whether this was a very extraordinary or a very ordinary phenomenon. If this 16 feet mark happened to be the mean level between high and low water, then it was a most ordinary occurrence; but if it was far removed from the mean level, then it was a most extraordinary, and almost inexplicable, phenomenon. Would Mr. Oldham enlighten them on this point?—Mr. Oldham gave an estimate of the variation in the tide levels at spring and neap tides, and the Chairman and Mr. Scott Russell, taking these figures, calculated from them what the mean level would be. Mr. Scott Russell was inclined to be of opinion that the 16 feet was as near as possible the mean level, and that, therefore, the tide at Hull was only doing what it ought to do, but he requested that at the next meeting or at some other time Mr. Oldham would lay before them a few carefully prepared statistics on the subject.—Mr. Oldham promised to do so, and the subject soon afterwards dropped.

Mr. Atherton followed with a report on freight, as affected by the difference in the dynamic performance of steamships. A short discussion followed, in the course of which Mr. Scott Russell spoke of the importance of using the best quality of iron in shipbuilding, so as to lighten the vessel whilst retaining its strength.

THE CONSTRUCTION OF THE NAVY.

Professor Crace-Calvert, F.R.S. read the next paper, "On some woods employed in the construction of the navy." He commenced with some observations on the necessity of a comparison of the various kinds of wood suitable for

shipbuilding, especially now that it was of such paramount importance to know which kind of wood could be best used in the construction of the new iron-plated frigates. He had examined ten different woods, and the superiority of some descriptions of foreign woods to our English oak could not be too strongly impressed upon the English nation. In woods grown in tropical climes, the highly-decomposible tannin of the English oak is replaced in some instances by resins, and in others by a substance similar to caoutchouc. This was the case with the Moulmein teak, with the Santa Maria and Moira woods, with the Honduras mahogany, and gave each of these woods a great advantage for purposes of shipbuilding over the English oak. He found, by experiments made some time since, that certain kinds of oak would attack iron three times as rapidly as the woods above mentioned. On the various kinds of wood being left in contact with water for five months, he found they lost of their substance in the following proportions:—Unseasoned oak, 24; seasoned oak, 12; African teak, 3½; Moira wood, 4; Honduras mahogany, 3; Santa Maria, 1·6; Greenheart, 5·6; Moulmein teak, 1·7. The facilities for mildewing and decaying were as follows:—Unseasoned oak, rapid; seasoned oak, rather less; African teak, Honduras mahogany, limited; Moira wood, and Santa Maria, and Moulmein teak, none. Further details on these points he proposed to give in a complete paper: but there was one point which he deemed it his duty to mention at once. During his researches he had found great difference between oak felled in summer and oak felled in winter; the latter was rich in tannin, whilst the former contained little tannin, but a large quantity of gallic acid. In examining some specimens of wood from the unsound gunboats furnished to him by some of the Government officials, he found the chemical composition of the wood of the sound gunboats was identical with that of seasoned oak felled in winter; whilst the chemical composition of the wood of the unsound gunboats was identical with that of unseasoned summer-felled oak.

Mr. BAILEY was of opinion that the differences which had come under the notice of Mr. Calvert, arose in a great measure from the character of the soil in which the timber was grown.—Admiral Sir EDMUND BELCHER remarked upon the great varieties and differences to be observed in English timber, and observed that wood, like fruit, rquired to be ripened.—Mr. HIGGINS mentioned circumstances which had come under his notice in Canada, which tended to prove the opposite of the theory promulgated by Mr. Crace-Calvert.—Mr. CALVERT replied that as yet his inquiries had been quite preliminary, and he intended to go further into the subject. They had, however, this fact, that in different kinds of wood grown in different parts of the world, he had found this same distinction between wood felled in the summer and wood felled in the winter.—At the close of this discussion, the section adjourned, a paper, by Mr. A. Henderson, on steam tug performance being deferred until the morning. The Chairman announced that next day the section would go fully into the question of the law of patent.

THE MICROSCOPIC SOIREE.

In the evening a Microscopic Soirée took place at the Free-trade Hall, and from eight o'clock until after ten the large hall, assembly-room, and drawing-room were densely crowded by a brilliant assemblage of upwards of 2,500 members of the Association. In the centre of the hall, extending three parts of the entire length, were ranged two long tables upon which were displayed about 50 microscopes, of various size and powers. Commencing with a microscopic circular of the Association for 1861, and a group of portraits of Davy Wollaston, Faraday, and Dalton, the exhibition entered upon the wide field of animal life. A section of the human brain, strikingly distinct, was followed by a section of a human finger, a tongue of a cat, part of the horn of an Indian ox, &c. The testacea were represented by embryo oysters; the birds by the feather of a humming bird; but it was in the insect department that this section of the exhibition was the strongest. The gizzard of a cricket, the eye of a beetle, and the foot of a spider; ludicrous as the bill of fare sounds, each presented an object of surpassing interest viewed through the microscopic lens. At the second table the exhibition was chiefly confined to the productions of the vegetable kingdom. Here, where all was so beautiful, it was scarcely possible to select one object as more worthy of notice than another, but the fungus on a leaf, exhibited by Mr. Mosley, and the pollen of mallow, contributed by Mr. Heys, were certainly not exceeded in beauty. In front of the orchestra, on two small tables, were placed a variety of products of the mineral kingdom, amongst which the hypersthene, exhibited by Mr. Janson, in a binocular microscope lent by Mr. Murray Gladstone, was perhaps the most admired. The models and other objects of interest (including a fine electrical machine) ranged round the walls of the building, and the beautiful works of art displayed in the galleries, divided with the microscopes the attention of the visitors. During the evening, Mr. W. T. Best, of St. George's Hall, Liverpool, gave, with fine effect, a selection from Handel, Mendelssohn, Beethoven, and other of the great masters, on the large organ of the Hall. In the gallery, a series of microscopes, representing anatomy and physiology, were placed; and in the ante-room and assembly-room and drawing-room, were further interesting miscellaneous objects. By far the greater number of the microscopes and objects were lent for the evening by gentlemen resident in the neighbourhood, to whom, certainly, a large amount of credit is due for their thoughtful liberality; but several eminent makers also contributed, their instruments and objects being arranged in the upper rooms.

FRIDAY, SEPT. 6.

PROCEEDINGS OF THE SECTIONS.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

This section met this morning at the Friends' Meeting House, Mount-street; Professor AIRY, D.C.L. F.R.S. presiding.

The PRESIDENT said that according to the printed journal Mr. Glaisher's report on the luminous meteors was the first subject to come before them, but it had been agreed by a general arrangement, that the question of meteors should be taken on Monday; mathematical subjects being taken at once, and the question of meteorites to-morrow (Saturday).—Several gentlemen suggested that the printed paper ought to be adhered to, as no doubt many had come to the section for the purpose of hearing the paper on meteors.—It was urged that the subject of meteors and meteorites was one and the same, and ought to be taken together.—The President said if it was the wish of the section, the printed paper would be adhered to, and Mr. Glaisher would submit his communication on meteors.

Mr. GLAISHER accordingly read a report "On Luminous Meteors." The report stated that during the year 1860 the number of meteors was very small indeed, the sky being continually overcast. But during the present year some hundreds of meteors had been seen. Having referred at length to the meteors which had been seen in this and other countries, he stated that sufficient attention had not been given to meteors, and he would urge on the members and friends of the Association to attend more to the subject, with the view, by extended observations, of ascertaining their distance from the earth, their path, size, and colour.

A paper by W. Von Haidinger was next read "On the Earlier Physical Condition of Meteorites, as well as some of the phenomena attending their fall on our planet." Some discussion followed.

Mr. J. P. GASSIOT, F.R.S. read a paper "On the Deposit of the Métal which takes place from the Negative Terminal of an Induction Coil during the Electric discharge in Vacuo." He said that when the electrical discharges by an induction coil were made from platinum wires, hermetically sealed in a vacuum tube, as usually constructed, the wire which was attached to the negative terminal of the coil shortly assumed the appearance of being corroded. This arose from very minute particles of the metal having been disintegrated and separated from the wire, which particles were deposited on the sides of the tube, in a lateral direction. If the wires were protected within the vacuum, by being covered with glass tubing extending about an eighth of an inch beyond the wire, it was the inside of the tubing that became coated with metal; but exclusive of this lateral action, a portion of the regular discharge would be observed to obtrude from the glass tubing in the form of a luminous brush. This luminosity was very sensibly affected by a magnet, and could in this manner be made to impinge on different parts of the vacuum tube; and wherever it was thus impinged heat was always evolved. This phenomena of the deflection of the negative discharge was described in a paper communicated by him to the Royal Society, and as he was subsequently desirous to examine with greater accuracy the nature of the deposit thus obtained from the negative terminal, and particularly if it could be obtained in the same manner from other metals than platinum, he had an apparatus constructed in which the discharge could be in slips of glass. The apparatus was also so constructed that wires of different metals could be inserted, and in this manner he succeeded in obtaining deposits of the following metals, viz. gold, silver, copper, platinum, zinc, iron, tin, lead, brass, magnesium, tellurium, bismuth, cadmium, and antimony. For many of these he was indebted to Mr. Matheson. With gold, silver, platinum, tin, and bismuth, the deposit would take place in the state as then exhibited after about 24 hours' action. If the discharges were continued the deposit became denser, and the centre was crystalline. With reflected light a large surface exhibited the lustre of the metal; with transmitted light the outer portion was transparent, showing the peculiar colour of the metals, as, gold, green; silver, bluish purple; platinum and tin, blackish grey. Tellurium, with the exception of antimony, he found disintegrated more freely than the other metals, while iron and magnesium were the most difficult, the deposit of the latter being scarcely perceptible. With alluminium wires he could not obtain any deposit after 48 hours' constant action. On one occasion he observed a faint trace on the glass, but on repeating the experiment with another wire no sign of any deposit could be obtained. Under the microscope the larger deposit of metal was not resolved into any form, but appeared as a mere film on the surface of the glass. From a brass wire terminal there was not any separation of the original metals. He had a tube constructed with two wires, both protected by glass tubing. A long slip of glass was inserted so that the discharges from the positive and negative terminals of the coil could be made with protected wires under the same conditions. The wires were of gold. The usual deposit took place at the negative, but after 24 hours' constant action not the slightest indication of any deposit from the positive wire could be observed. With antimony, a very peculiar effect was obtained. Instead of the metal being deposited in a circular form, it spread nearly all over the glass, and on the sides of the vacuum tube. He repeated the experiment by inserting slips of glass of sufficient length as to reach beyond the terminals. Two of those glasses were on the table, and if examined it would be seen that the positive discharge had apparently repelled the deposit as it formed from the negative wire, leaving a space somewhat analogous to the dark band which appeared in the luminous. Whatever might be the cause of the difference in the action of the electrical discharge between the positive and the negative, the disruption of the particles of metal in the latter was merely mechanical. The minute particles were disrupted by the force of the discharge, which, at the negative, met with resistance, and which resistance, under certain conditions, was attended with considerable heating effects, as if the wires were there, the negative invariably fused whether the discharges were made in air or in vacuo.—A short discussion followed, and the President, in moving the thanks of the meeting to the author, said the communication was one of the most valuable contributions that had recently been made to physical science.

Professor PRICE offered a few observations on the apparent path of a projectile, as affected by the rotation of the earth, explaining that a ball discharged due north did not go due north, but travelled by a curve on one side.

Mr. W. SPOTTISWOODE, F.R.S. communicated some observations "On the Canonical Form of the Decadic Binary Quantie," and also "On Petyzal's Asymptotic method of Solving Differential Equations."

The next communication was by Mr. J. ALEXANDER DAVIES "On the production of Colour by the Prism; the passive mental effect or instinct in comprehending the en-

largement of the visual angle and other optical problems."

Mr. JOHN SMITH read a paper "On an experiment, being an attempt to illustrate the Roseate Phenomena seen during total eclipse."

SECTION B.—CHEMICAL SCIENCE.

The meeting of this section was held at Owens College. A numerous audience filled every part of the theatre. Professor W. A. MILLER, M.D. F.R.S. took the chair about eleven o'clock.

The PRESIDENT said that the meeting was honoured by the presence of some men of science to whom we owe in a great measure our knowledge upon this subject. He was happy to see Sir David Brewster, Dr. Robinson, and Professor Wheatstone. His object on the present occasion was to show a few photographs, produced by electric light and sparks.

PHOTOGRAPHIC SPECTRA OF THE ELECTRIC LIGHT.

The apparatus by which the spectra may be photographed consists of an ordinary camera obscura attached to the end of a long wooden tube, which opens into a cylindrical box, within which is a prism glass, or a hollow prism filled with bisulphide of carbon. If the prism be so adjusted as to throw the solar rays, reflected from a heliostat upon the screen of the camera, and the wires which transmit the sparks from Ruhmkoffer coil, are placed in front of the uncovered portion of the slit, the two spectra are simultaneously impressed. The solar beam is easily intercepted at the proper time by means of a small screen, and the electric spectrum is allowed to continue its action for two or three, or six minutes, as may be necessary. He did not find that anything was gained in distinctness by interposing a lens of short focus between the slit and the wire which supplied the sparks, with the view of rendering the rays of the electric light parallel like those of the sun, owing to the absorbent action of the glass weakening the photographic effect; and the flickering motion of the sparks being magnified by the lens, rendered the lines less distinct than when the lens was not used. Although with each of the metals (including platinum, gold, silver, copper, zinc, aluminium, magnesium, iron), when the spark was taken in air, he obtained decided photographs. It appeared that in each case the impressed spectrum was very nearly the same, proving that few of the lines produced were those which were characteristic of the metal. The peculiar lines of the metal seemed chiefly to be confined to the visible portion of the spectrum, and these had little or no photographic power. This was singularly exemplified by repeating the experiment upon the same metal in air, in a continuous current of pure hydrogen. Iron, for example, gave, in hydrogen, a spectrum in which a bright orange and a strong green band were visible, besides a few faint lines in the blue part of the spectrum. Although the light produced by the action of the coil was allowed to fall for ten minutes upon a sensitive collodion surface, scarcely a trace of any action was procured; whilst, in five minutes, in the air, a powerful impression of numerous bands was obtained. It was remarked by Mr. Talbot that, in the spectra of coloured flames, the nature of the acid did not influence the position of the bright lines of the spectrum, which he found was dependent upon the metal employed, and this remark had been confirmed by all subsequent observers. But the case was very different in the absorption bands produced by the vapours of coloured bodies,—there the nature of both constituents of the compound was essentially connected with the production of absorptive bands. Chlorine, combined with hydrogen, gave no bands by absorption in any moderate thickness. Chlorous acid and peroxide of chlorine both produced the same set of bands, while hypochlorous acid, although a strongly coloured vapour and containing the same elements, oxygen and chlorine, produced no absorption bands. Again, the brownish red vapour of perchloride of iron produced no absorptive bands; but when converted into vapour in a flame this gave out bands independent of the form in which it occurred combined. These anomalies appeared to admit of an easy explanation of the supposition that, in any case, the compound is decomposed in flame, either simply by the high temperature, just as water is, as shown by Grone, or, in all other cases of the production of bright lines by the introduction of a metallic salt into a flame of burning bodies (as shown by Deville). In the voltaic pole the decomposition must of necessity take place by electric action. The compound gases, protoxide and binoxide of nitrogen, gave, when electrified, the same series of bright bands (as Plücker had shown), which their constituents when combined furnish. Aqueous vapour always gives the bright lines due to hydrogen and hydrochloric acid, the mixed system of lines, which could be produced by hydrogen and chlorine. The reducing influence of the hydrogen and other combustible constituents of the burning body would decompose the salt, liberating the metal, which would immediately become oxidised or carried off in the ascending current. There was obviously a marked difference between the effect of intense ignition upon most of the metallic and the nonmetallic bodies. The observation of Plücker upon the spectra of iodine, bromine, and chlorine show that they give, when ignited, a very different series of bands to those which they furnished by absorption, as Dr. Gladstone had already pointed out; but it was interesting to remark that in the case of hydrogen which, chemically, was so similar to metal, we have a comparatively simple spectrum, in which the three principal bright lines correspond to Fraunhofer's dark lines, C. F. and G. It was, however, to be specially noted that the hydrogen occasioned no perceptible absorption bands at ordinary temperatures in such thickness as we could command in our experiments, and the vapour of boiling mercury was also destitute of any absorptive acaction, although when ignited by the electric spark, it gave a characteristic and brilliant series of dark bands. The following experiment suggested itself as a direct test of Kirchoff's theory. Two gas burners, into which were introduced chloride of sodium on the wick of the spirit lamp, were placed so as to illuminate equally the opposite sides of a sheet of paper partially greased. The rays of the electric light screened from the photometric surface, suitably protected, were made to traverse one of the flames. If the yellow rays of the light were absorbed by the sodium flame, the light emitted laterally by the flame should be sensibly increased. The experiment, however, failed to indicate any such increase in the brilliancy of the flame, possibly because the eye was not sufficiently sensitive to detect the slight difference which was to be expected.

Some discussion followed, in which Dr. Gladstone, Mr. Alexander Bryson, optician, of Edinburgh, and Mr. Warren de La Rue took part.

Dr. J. H. GLADSTONE then read a paper "On the Emission and Absorption of Rays of Light by certain Gases," and a paper by Dr. J. H. Gladstone and Mr. G. Gladstone, "On the Aluminous Mineral, from the Upper Chalk near Brighton."

Professor CRACE CALVERT read a paper "On the Chemical Composition of some Woods employed in the Navy," and a paper "On the Chemical Composition of Steel," in which he gave some details respecting the interesting discussion which has lately taken place before the French Academy of Science, between Messrs. Fremy and Caron, on the chemical composition of steel. Professor Calvert considers that the molecular condition of steel has a great deal to do with the nature of its chemical composition; for if a piece of soft steel is divided into two portions, and one of them hardened and highly tempered, the slow action of acetic acid proves to be quite different; for whilst soft steel is scarcely acted on by weak acetic acid, hard steel is rapidly dissolved.

Dr. W. ROBERTS read a paper "On the solvent powers of weak and strong solutions of alkaline carbonates on uric acid calculi."

Dr. SMITH (of Sydney) read a paper "On certain difficulties in the way of separating gold from quartz."

SECTION C.—GEOLOGY.

Sir R. I. MURCHISON again presided yesterday; and the lecture theatre of the Royal Institution, including the gallery, was crowded for the first two or three hours.

Professor OWEN read a paper "On the Remains of a Plesiosaurian Reptile (Plesiosaurus Australis), from the oolitic formation in the middle island of New Zealand." The author remarked that it had been said that "the further we penetrate into time for the recovery of extinct animals, the further we must go into space to find their existing analogies;" and that "in passing from the more recent to the older strata, we soon obtain indications of extensive changes in the relative position of land and sea." He cited some striking examples in proof of these positions from the reptilian class. The mosasaurus of the cretaceous series occurs in that series in England, Germany, and the United States. The polyptychodon occurs in the same series at Maidstone and at Moscow. Toothless lacertian reptiles have left their remains in triasic deposits at Elgin, in Shropshire, and at the Cape of Good Hope. Dicynodent reptiles occur in the same formations at the Cape and in Bengal. The plesiosaurus, with a more extensive geological range through the jurassic or oolitic series, has left representatives of its genus in those mezozoic strata in England, and at her antipodes. Evidence of this extreme geological range had been submitted to Professor Owen, by Mr. J. H. Hood, of Sydney, New South Wales, obtained by him from the middle island of New Zealand. This evidence consisted of two vertebral bodies, or centrums, ribs, and portions of the two coracoids of the same individual, all in the usual petrified condition of oolitic fossils. The Professor minutely described the fossils, pointing out the confirmatory evidence that they were plesiosaurian; the most decisive proofs being drawn from the vertebral centrums. The specimens are now in the British Museum.

Professor OWEN next made a communication "On a Dinosaurian Reptile (Scelidosaurus Harrisoni) from the lower lias of Charmouth." He said that the reptile of which he was about to speak belonged to the remarkable order exhibiting modifications of the reptilian structure, as we now knew it in crocodiles and lizards, as adapted for life on land. The evidences as to the order dinosauria were first made known by the discoveries of Mantell and Buckland, from examples found in this country. The remains had been found in the upper green sand deposits of our cretaceous system, downward through the wheildon, and as regarded the megliosaurus as far down as the great oolitic bed; but until very recently that was the oldest formation from which any evidence of a dinosaurian reptile had been the property of science. Mr. Harrison, a retired medical gentleman, residing at Charmouth, on the Dorset Coast, near the magnificent liasic cliffs that had afforded such rich evidences of modern reptilia, had devoted his leisure to the collection of fossil remains from those cliffs. About three years ago, Mr. Harrison obtained from a part of the cliff which was an upper member, if not the uppermost, of the lower lias, some fragments of limb bones, of so novel a character, that he sent them to him (Professor Owen) for his opinion. He was surprised to receive such things from that locality and formation; seeing that the fragments presented unequivocal evidence of the dinosaurian reptile, and of one which, judging from the femor, was closely allied to the iguanadon. Mr. Harrison was quickened in his researches by such a reply; he offered rewards to the quarrymen; and at length he received the most complete skeleton of dinosaurian reptile ever obtained from any formation or locality. Fortunately it was almost complete as regarded the skull and the means of dentition—a part of the osteology of the order which all were most desirous to know. Preceding inquiries had only made us acquainted with the lower jaw of the iguanadon, part of the lower jaw of the megliosaurus and hylosaurus, together with some small obscure fragments of the upper jaw of the iguanadon. As to the complex cranium our knowledge was a blank until this happy and remarkable discovery. The skull was entire, with the exception of the end of the snout; in fact, it was entire for all the purposes of the comparative anatomist. So were the neck and trunk vertebræ, the sacrum, the pelvis, and a great portion of the vertebræ of the tail. The learned Professor described in detail the various portions of the skeleton; pointing out where they nearly resemble those of the iguanadon and the megliosaurus.—There was a short discussion, in which Professors Phillips and Sedgwick spoke of the value to geology of both the discoveries.

The other papers were—Professor Harkness, "On the sandstones and their associated deposits of the valley of the Eden and the Cumberland Plain;" Mr. Harry Seely, "On the Elsworth rock and the clay above it;" Rev. W. S. Symmonds, "On some phenomena connected with the drifts of the Severn, Avon, Wye, and Usk;" Mr. George W. Morton, "On the pleistocene deposits of the district about Liverpool;" and Professor Phillips, "Notice of some facts in relation to the post-glacial gravels of Oxford."

SECTION D.—ZOOLOGY AND BOTANY.

Professor BABINGTON presided in this section, which assembled in one of the exhibition rooms of the Royal Institution. Mr. J. G. JEFFREYS read a "Report of the deep-sea dredging in Zetland, with a notice of several species of Mollusca, new to science or to the British Isles." Three species new to science had been discovered, together with twelve new to Great Britain. There were two or three other reports on dredging; and the following papers were read:—

Mr. P. L. Sclater: "Report of the present state of our knowledge of the species of Apteryx, living in New Zealand;" and a "Preliminary report on the present state of our knowledge of the terrestrial Vertebrata of the West Indies."

Dr. Daubeny: "On the influence exerted by light on the functions of plants;" "On a violet peculiar to the calamine rocks in the neighbourhood of Aix la Chapelle;" and "On the functions discharged by the roots of plants."

Rev. T. Hincks: "Notes on the Ovicells of the Polyzoa, with reference to the views of Professor Huxley."

SUB-SECTION D.—PHYSIOLOGY.

This sub-section assembled in one of the large exhibition rooms at the Royal Institution; Dr. JOHN DAVY, F.R.S. presiding.

PRISON DIET AND DISCIPLINE.

Dr. E. SMITH read the second and concluding portion of the first part of the report by himself, and Mr. W. R. Milner, medical officer of the convict prison at Wakefield, "On the influence of prison dietary and punishments upon the bodily functions of prisoners."

The Committee detailed the results of a considerable number of experiments as to the effects of prison discipline on the excretion of nitrogen and other substances. The Committee think that the time is approaching when the whole subject of prison discipline must be reconsidered, and when a conclusion may be arrived at as to the propriety of continuing a system which, when practised, occasions a vast waste of the vital powers of the prisoners, and vast expenditure of money to provide a dietary, which, although scarcely sufficient, is far beyond that provided for the poor in workhouses, and beyond that obtained by the working classes in general. The different systems pursued in prisons is furnishing some evidence as to the relative value of three plans—Waste of animal force by the treadwheel and the crank; the use of manufacturing operations; and the result of simple detention and instruction, without labour. These conjoined with the intelligent efforts put forth in Ireland, may almost suffice to guide those to whom the consideration may be entrusted. It is certain that if much

bodily labour be enforced, whether profitably or unprofitably, there must be an expensive dietary; and no plan can be so wasteful as that which enforces profitless labour and supplies an expensive diet to meet its wants. Steps should be taken to secure uniformity in discipline; and the mode of carrying out sentences should be proportioned to the crime. This might be done in the dietary, and yet allow of such varieties of food as might be found relatively economical in different parts of the kingdom; for the quantities of each kind of food that will supply equal amounts of nutriment may be estimated. So with respect to instruments, they may be kept in proper order, and care be taken that the speed at which they are worked shall be uniform; the amount of a day's work would thus be the same throughout the kingdom, and the surgeon must decide as to the fitness of a particular person to perform the required task. A committee of scientific men, properly authorised by the Government, would find no difficulty in placing all this upon a proper basis. It is easy to estimate the amount of labour required in ordinary manufactures; but the Committee think that when all the care suggested has been taken, the effect of labour on the treadwheel and at the crank, as well as of "shot drill," will still be very unequal upon prisoners, as it varies according to height, weight, age; and previous occupations, and must therefore be at all times objectionable. The Committee defer their recommendation as to the exact adaptation of labour to supply of food; but as it involves the fundamental question of the propriety of making the dietary an instrument of punishment, it is necessary *in limine*, to decide it. When Sir James Graham appointed the commissioners to draw up the present scheme of dietary, he expressly directed that the dietary should not be used as an instrument of punishment; but the committee affirm that the food supplied on the lowest scale is so totally inadequate to the wants of the system that it can only be regarded as an instrument of punishment. That it is so regarded may be inferred from the dislike which old offenders have to short imprisonment with its low dietary, and by the value which magistrates attach to this their most formidable agent. A dietary of bread and water, or bread and gruel, cannot be enforced without injury to the prisoner's health; and that this is fundamently recognised may be inferred from the fact that all men agree that a high scale of dietary is absolutely demanded in long imprisonments. The injury is one of degree; and short imprisonment prevents ill effects being observed, which with a long imprisonment have been proved to increase the mortality in gaols. The Committee hope that on philanthropic grounds the principle may be established that the prisoner shall not be so treated that when he leaves the gaol he shall be less able to earn his living than when he entered it; and that punishment and reformation being sought together, some plan may be adopted which will accord with that principle. The value of the system of extra dietary cannot be too highly estimated; but the very admission implies a defective adaptation of the general scheme to the wants of the system, and that almost the life of the prisoners throughout a large part of the imprisonment is at the discretion or the negligence of the surgeon. Bread is proved by the experiments of the Committee to be less nutritive than milk. Mere detention in prison lessens the power of assimilation, so that a greater quantity of food must be required for performing given labour in prison than would be necessary out of prison. The object of extra diet is rather to aid the system in making a better use of the food ordinarily supplied, than to give additional material. Extra diet of bread (when the dietary is in the highest scale) is almost sure to be wasted. In conclusion, the Committee urge the great importance of making better use than hitherto of the unparalleled opportunities which prisons afford of working out the most important questions in nutrition. Better prison management might thus be secured, and an advance would be given to science as essentially connected with the daily life of the community. Such questions are—The true value of brown bread over white bread in prison and other dietaries; the exact influence of various kinds of food, such as tea, coffee, milk, and alcohol, which act chiefly in influencing other food; the exact relation of a given quantity of food to a given amount of labour; the cause of the defective power of assimilation of food in prisons; and the relative elements of the food taken to those which are fixed in and thrown out of the body.

An interesting discussion followed.—Professor BAIN (Aberdeen) thought that it was impossible to keep up a good state of health, with the chronic irritation which imprisonment almost naturally produced. He also suggested that without diminishing the amount of nutrition, food might be supplied which should be unpalatable; and that, some kinds of pain being less injurious than others, bodily pain might be inflicted instead of a restriction of diet.—The Rev. Mr. BUTLER, vicar of Sandal, near Wakefield, said that he had seen men come out of prison very much reduced in health and strength, and with the powers of earning a living consequently very much diminished, owing as he believed, to the compulsory idleness to which they had been subjected.—Dr. ROLLESTON said that Liebig had recommended the use of brown bread; and many wealthy persons who took a little and benefited thereby, thinking that it would have a like effect with others, had caused it to be used in workhouses and prisons. But it was found that the irritation of the bowels caused by the brown bread, which was beneficial to those who had plenty of other food, and insufficient exercise, caused a great waste to those who were very differently situated. In fact, in prisons and workhouses, brown bread was less nutritious and more expensive than white.—Dr. MOUAT, medical superintendent of Government prisons in Lower Bengal, while he concurred generally in the views of the reporters, and admtted their very great value and interest, remarked that he was not quite prepared to admit the soundness of all their conclusions. The machinery for uniformity of system existed in the prisons under his charge, but however exact rules and regulations were, some diversity must exist in carrying them out, dependent on the differences of human agency. In short-term convicts, and those beginning a career of crime, the prison should be rendered as distasteful as possible, and all severity in the way of restriction of food and exaction of labour were not only justifiable but necessary, short of injury to health. The interests of society needed to be considered quite as much as those of the individual. The effects of deterioration caused by cranks and tread wheels were greatly due to the absence of results, and of mental occupation—the mind playing a very important part in all questions connected with this subject. His doctrine was, that *vace* physiology and its deductions, the objects of imprisonment were the protection of society, and the punishment of the individual, with his restoration to society, if possible as a better and a wiser man—and all measures of severity, whether in diet or labour, that fell short of actual injury to health, were not only justifiable, but were consistent with the humanity that now guides all such measures.—Mr. W. R. MILNER said he considered that loss of weight was a very important indication of failing health, when it continued for several months in succession; and he had frequently found men fall off in weight for some time, who presented no other indication of failing health. He objected to the principle of low diet for short terms of imprisonment. If a man had only one imprisonment, to keep him on bread and water, or bread and gruel, for the fortnight or three weeks, might not be of any serious consequence. But it was often the case that a man got into prison several times in a year—he knew a case in which a man was 42 times sent to gaol in twelve years—then the succession of short imprisonments with low diet would, in the end, break down the health of the man. In the case to which he had referred, the surgeon was obliged, after the first two or three years, to give full diet to the man as soon as he came into the prison. He quite agreed with Dr. Mouat that crank

and treadwheel labour was more injurious to a man in prison than an equal amount of labour out of it in which the mind was interested; and he had found prisoners who were failing in health while doing light work, such as picking coir, or sewing pieces of cloth together, gain health, strength, and weight, when put to more laborious work in which the mind could be interested. Men could not do the same amount of work alone in a cell, as they could when working in association or out of doors. He quite agreed with Dr. Rolleston that brown bread was unfit as an article of diet for working men. Its use was commenced in the Wakefield prison; but the effects were so bad that in a few months he was compelled to report against it, and it was discontinued. There was a great deal of sickness during the time; but the diseases which he attributed to the brown bread disappeared when better was substituted, A member had asked what the rate of mortality was in prisons, and whether it was in any way affected by insufficient diet. He could only say that in the Wakefield gaol the rate was 14 in 1,000; that in prisons everywhere it was high; and that the diseases were chiefly forms of scrofula and consumption, which were diseases dependent upon defective nutrition. He agreed with Professor Bain as to the irritation which imprisonment produced; and he thought that by no system of prison discipline would it be possible to maintain perfectly vigorous health amongst prisoners. As to another remark by Professor Bain, he (Mr. Milner) thought that, medically speaking, a man might much better be whipped than subjected to a repetition of punishment consisting of imprisonment in his own or in a dark cell, upon a low diet of bread and water. He could not at all agree with Professor Bain's suggestion as to punishing by means of unpalatable food; for a pleasurable feeling in eating was essential to obtaining a due amount of nutrition from the food taken. He had found that it was absolutely necessary to give prisoners abundant work—as far as possible of a kind that would occupy the mind as well as exercise the body—in order to preserve their health.—At the close of the discussion, it was moved by Dr. Mouat, and seconded by Dr. Gibb—

It is proposed as a recommendation from the Sub-Committee on Physiology, that the report of Dr. Smith and Mr. Milner on Prison Discipline and Dietary be published *in extenso*, with all its annexures; both on account of its intrinsic value, and as a guide to others in various parts of the country in conducting the same inquiries. Likewise that extra copies be presented, and that one be sent to each prison in the British domains, for the use of the medical staff and the visiting magistrates.

The resolution was unanimously adopted.

The other papers were- Dr. James Turnbull, M.D. "On the Physiological and medicinal properties of sulphate of aniline, and its use in the treatment of chorea."

Mr. Joseph Toynbee, F.R.S.—"The action of the Eustachian Tube in man, as demonstrated by Dr. Politzer's otoscope."

Dr. John Davy, F.R.S.—"On the blood of the common earthworm."

Professor Remak.—"Upon the influence of the sympathetic nerve on voluntary muscles, as witnessed in the treatment of progressive muscular atrophy by secondary electric currents."

Section E.—GEOGRAPHY AND ETHNOLOGY.

The proceedings in this section were conducted by the President, John Craufurd, Esq., in the Lecture-hall of the Mechanics Institution, David-street. The attendance was large, and included a great number of ladies, the announcement of a paper, by M. Du Chaillu, the African explorer, doubtless attracting many of the audience.

Mr. Henry Wise read the first paper, which was entitled "Remarks on a proposed railway across the Malay Peninsula." It shewed that this railway would save a distance of about 700 miles, by connecting the Bay of Bengal and Indian Ocean with the Gulf of Siam and China and Japan Seas, and precluding the necessity of pursuing the circuitous and precarious navigation of the Straits of Malacca. The government of Siam had sanctioned the construction of the railway, for the praiseworthy reason that it was connected with the advancement of civilisation. The length of the railway will not exceed forty-five miles, and the transit of mails and passengers overland from the Bay of Bengal to the Gulf of Siam, or *vice versâ*, would be accomplished in two hours. The present passage was made by steam vessels in four or five days, but was seldom performed by sailing vessels in less than three weeks. The experience of Major Tremenheere, with respect to the proposed undertaking showed that no great physical difficulties would have to be overcome in the construction of this line. The line would greatly facilitate the extension of the telegraph to China, by affording protection to the stations on the line. The cable from Rangoon, along Cochin China, to Hong-Kong, would be liable to far less casualties than that by the Straits route. The district through which the line would pass contained coal, tin-ore, or valuable natural productions. In the neighbourhood was an abundance of natural woods. The entire area of the Malay Peninsula was about 83,000 square miles. The importance of this railway to British policy and progress in the East was incalculable.—General Chesney commented on the vast importance of this line to Manchester and this country at large, and moved that the subject should be referred to the Recommendations Committee, for being brought before Parliament, which was seconded by Mr. George Bailey.—The President, while differing on some few points with the author of the paper, advocated the project, giving some details of his own experience at Singapore. He believed that the Chinese could produce a considerable amount of good cotton in Siam.—After a few remarks from Mr. Wise, in reply to some of the Chairman's remarks, it was resolved to refer the question to the Recommendations Committee; and a vote of thanks was given to Mr. Wise for his paper.

The next paper, read by its author, Captain Cameron, H.B.M. consul at Massonah, was "Notices of the ethnology, geography, and commerce of the Caucasus." The locality referred to was the Caucasian Isthmus. Hercules, Castor, and Pollux, Ulysses, and other Greek worthies were all said to have done something towards opening the Caucasus to the enterprise of their countrymen. It grew to be pre-eminently a land of marvels. After reference to the ancient traditions of the Amazons, it was stated that the Caucasus had played its part in history, and especially made itself felt in the movements of the two important continents which it both separated and linked together. The Caucasus was a laboratory in which nature had been working on the largest scale, and magnificent results were given in its varied geological formation, &c. The beginning of the establishment of the Cossacks in the Caucasus dated some centuries back, and their numbers were systematically augmented by Peter the Great and his successors. After a reference to the various Tartar tribes, and to the Tcherkissis, whose habits were graphically described, other portions of the inhabitants of the Caucasus were similarly noticed. So far from Schamyl being the chief of the Circassians, they looked upon his "levelling" system of government with suspicion and dislike; and it was only among the Tchetchenses and Lesghas that Schamyl had any power. The Caucasus possessed every diversity of soil; it was capable of producing indigo and cotton. The silk trade had received a stimulus by the failure of the supply in other quarters. During the Irish famine, 125,000 bushels of Indian corn was exported to this country. In the Caucasus, as elsewhere in the East, Swiss manufactures were gaining rapidly on those of England, a fact which Mr. Hernes ascribed to the circumstance that hand-loom patterns and colours could be constantly varied without difficulty or expense, which, he said, was not the case with power-loom weaving. In the bazaars in Mingrelia, however, the average of British goods as against Swiss was generally as three to two. Steam had been introduced both on the Black and Caspian Seas and elsewhere.—The President remarked that the document was one of

the best which had been read at any section of that Association. He considered that Mynheer Blumenbach and Cuvier were wrong in supposing that our race came out of the Caucasus. They were something a great deal better than that, the majority of the natives of that district being barbarians.—Mr. H. Spottiswoode made a few remarks, and Professor Wilson mentioned various circumstances which tended to show that the English nation and the Caucasian were related.—A vote of thanks having been given to the author of the paper,

The PRESIDENT announced that the next paper was to be read by M. Du Chaillu.—(Applause.)

M. DU CHAILLU remarked that he had come to Manchester to learn, and not to read papers; but some of his friends thought a paper from him might prove interesting, and he had consented to write one and read it before them. He then read his paper, "On the geographical features and natural history of a hitherto unexplored region of Western Equatorial Africa." This singular region, explored by the author during the years 1856-7-8-9, lay within two degrees on either side of the equator, and extended for 400 miles into the interior. Having described its physical features, its partly swampy, partly mountainous character, and its dense forests, which ascend to the very tops of the mountains—its rivers, the Muni, the Moondah, and the Gaboon, all rising in the range of mountains known as the Sierra del Crystal, 60 or 80 miles from the west; also the Nazareth, the Mexias, and the Fernand-vas, the latter chiefly fed by the Ogobai, and this last fed by the Rembo Ngouyai and the Rembo Okanda—the traveller, reverting to the mountains, said, "Judging from my own examinations, and from the most careful inquiries among the people of the far interior, I think there is good reason to believe that an important mountain range divides the continent of Africa nearly along the line of the equator, starting from the west from the range which runs along the coast north and south, and ending in the east, probably in the country south of the mountains of Abyssinia, or perhaps terminating abruptly to the north of the lake Tanganyika of Captains Burton and Speke." To the existence of this range, and of the flat, wooded, damp country at its foot, he attributed the fact that Muhometanism had never in Africa spread south of the equator. The natural history of the country was next referred to at some length. With regard to the gorilla, he considered it probable that its range was co-extensive with the dense jungle of the interior. He had no doubt that with the advance of civilisation in that region, this monster would disappear; and it was a great satisfaction to the scientific world and to himself to know that, whatever might happen, the world would have from the pen of one of its most illustrious zootomists, Professor Owen, an imperishable record of the most wonderful anthropoid animal yet described. M. Du Chaillu here concluded his paper, but was called upon to "Go on." He said he had not referred to other portions of the subject because they did not come under that section. He then proceeded to remark on the habits of the gorilla. The scene in the forest of Africa was far different from a sketch which was hung upon the wall, representing his encounter with one of those animals. He said: I remember when, wandering through the forest one day, I saw the footsteps of the monster. Immediately, my men, who were with me, began to be afraid, and we had a party of women also; and all ran away. I thought I had found my game, and was not disappointed. I told the men if they took a step in the wrong direction I would send a bullet in the right direction; so they followed me. We put the women safe, and those afraid, and I took a few of my men and followed the track. The animals which we met, however, were young ones; they ran away. Another time, I have pursued a monster about two hours through the jungles. My clothes were torn, and I was covered with blood—for it is difficult to hunt in these jungles. I had given up the beast entirely; I was hungry and tired, and began to grumble at my men for having told me that the gorilla had ever attacked men. Suddenly I was startled by the roar of the monster, and through the dark jungle I saw an animal raise himself on his hind legs and roar and beat his chest in the most appalling way. Though accustomed to wild animals, I felt my nerves were not quite strong. Happily they kept strong enough for me to shoot the monster; but afterwards I shook like a leaf about fifteen minutes, my horror was so great. The gorilla looks straight at you; the orbs of his eye being like those of other apes, but they are tame. Looking at you with his grey eyes, and the hair of his head parting a little, and beating his chest like the beating of a drum, I was really afraid—I was a great fool, for I had then escaped. I have seen trees—not one, but dozens of them, which have been broken by the powerful arm of this monster. I had a man who died from a blow of the gorilla, having his ribs smashed. I am not the first one who has spoken of these animals. Professor Owen had a skeleton of one before I had killed the one since brought to England; and he mentioned the enormous trunk of the beast, only it was my good fortune to see one alive; and I have corroborated many of the facts which his science taught him to believe, and which were true. The gorillas live in the forest by themselves. They roam alone. The female sometimes will sleep in the top of a tree, and the male at the foot. The specimen at the British Museum has the hair entirely worn off at the back, probably from its having sat continually. The male gorilla sits and sleeps at the foot of the tree, but if he hears the noise of any wild beast coming round, then he goes to the top of the tree. As far as my knowledge brings me, I find the male gorillas always attacking; while madame gorilla always runs away. It is a good thing, because if the two came to attack together I don't know what would become of the poor hunter. It is another good feature of Providence that we know such huge a beast is always alone. If they were in companies I would not be found to go to shoot them, even if but two together. I would rather go into Scotland and shoot grouse, I assure you.—(Laughter.) M. Du Chaillu thanked the meeting for the kindness they had shown him, and was warmly applauded at the close of his remarks.

The PRESIDENT spoke of the general features of the country described, mentioning the fact that a palm grew there, the produce of which was now imported into this country to the extent of £1,500,000 sterling worth for use in greasing the wheels of locomotive carriages.—Dr. ROYD asked how many shots were required to kill the gorilla, and what were the general facts with respect to its tenacity of life. M. DU CHAULLU replied that the animal died very easily when wounded in the chest. In the case of the one in the British Museum, which was killed by his man and himself, his gun was loaded with a bullet, and the man's contained several pieces of iron. One of the shots hit the animal in the neck and the other in the chest. He had killed some with a single bullet, but generally he and his man hunted in company. Many animals were more difficult to kill than gorilla.—Dr. ROYD: A very great blessing. (Laughter.)—The PRESIDENT remarked that the locality referred to in the paper which had been read ought to be of more interest than the history of mere monkeys, however grand—and the gorilla was the king of all monkeys—though, by the by, Professor Owen had shown that his brain was smaller than that of the smallest chimpanzee.—M. DU CHAILLU then received the thanks of the meeting for his paper.

Dr. JAMES HUNT, Ph.D., F.S.A., &c. then read an able paper "On the Acclimatisation of Man." He remarked that the generally received opinions with respect to the laws which regulated the health of man in his migrations in the world were vague and unsatisfactory. They were told that man could thrive equally well in the tropics and at the poles. Nothing could be gained in climatology from *a priori* argument, as it was entirely an experimental science. The question demanded the serious attention, not only of ethnologists, but of all interested in the great problem of man's future destiny. Civilisation greatly aided man to adapt himself for a time to every climate. The conditions which prevented and retarded the acclimatisation of man were physical, mental, and moral; and

these causes were insensibly bound together. Man might live where the temperature exceeded the heat of his blood, and also where the mercury would freeze. Every family of the human race presented different modifications, which were doubtless influenced in some way by the nature of the cosmic influences by which they were surrounded. In every climate they found man organised in harmony with that climate, and from which he could not be removed without more or less disadvantage. The general scale of power for enduring change appeared to be in unison with the mental power of the race. That the greatest power of acclimatisation was possessed by Europeans none could deny, but there was not a shadow of evidence to prove that the European could propagate his race in any part of the world. The subject, however, could not be settled by authority, and on many points the evidence was most contradictory. There could not be much doubt that the mind had considerable power in repelling epidemics, &c. The Jewish race apparently thrived all over the world. That the Jews, at the earliest historical date, were in Asia he did not attempt to deny, but was not disposed to admit that they were originally of Asiatic origin. They might be remnants of Phœnician traders or others. Certain temperaments, irrespective of race, were better suited for hot and others for cold climates.—The PRESIDENT remarked on the able character of the paper. He considered, however, that the Chinese race was in many respects superior to the European: that nation thrived from the equator to the 50th degree of north latitude.—Some discussion then ensued with respect to the Jews.—After some remarks from Dr. Beddow, the Rev. HAMILTON GRAY said that Dr. Hunt had stated that the Jews were not of Asiatic origin. He would ask, then, what they were. As Niebühr had deranged all their ideas of Roman history, and as Froude had deranged all our Tudor history, in like manner did Dr. Hunt derange all our notions of ancient history by controverting what had been asserted—to say nothing of inspiration—in the most ancient and generally recognised historical document, with respect to the origin of the Jews. If they were not an Asiatic people, what were they?—Dr. HUNT said he had simply asserted that they were probably remnants of Phœnician traders. There was no instance of any pure Asiatic race existing and flourishing in Europe as the Jews did.—The Rev. H. GRAY replied that those inferential proofs did not serve to invalidate the document to which he had referred.—The PRESIDENT said the Bible said nothing about Asia, which was a modern word coined long afterwards.—The Rev. H. GRAY said that the word Asia was generally understood to refer to a certain quarter of the globe.—Professor WILSON said there could be no doubt that the modern inhabitants of Europe had an eastern origin.—Professor SEDGWICK referred to various circumstances which had tended to retard the progress of the African and other nations, and the moral and political advantages of such as the Anglo-Saxon.—The PRESIDENT differed with Professor Sedgwick as to his belief that he himself was a Hindo-European.—M. DU CHAILLU expressed his belief that if a thousand Frenchmen were sent to Senegal, and were pledged to stay there ten years, there would not be 50 of them left at the end of that period. Immediately an European began to dig the soil, he caught the fever. There had been cases of drunken sailors losing their hats, and in five or ten minutes receiving such injuries from the effects of the sun upon their heads, that they had died the same day. It was a strange thing that even the negro did not seem to thrive in most parts of Western Equatorial Africa. If Europeans had fevers when there, the negro had them. He did not believe the white man could live on the western coast of Africa.—Mr. WISE said his experience went to show that mortality amongst both military and naval officers was proportionately smaller than amongst the men; and he believed the true cause of that was included in that sentence, the "influence of the mind." Mental prostration was the greatest difficulty which military and naval men had to contend with. The men, when suffering from the effects of adverse climate, scarcely seemed to have any desire to recover; whilst the officers felt they had something to live for. Captain PARKER SNOW confirmed the remarks of the last speaker. He had been to the extreme north and south—to the East and West Indies, Africa, North and South America, several times to Australia, and other parts of the globe; and he was able to testify to the power of man in resisting the evils of climate, if he would only bring moral influences to bear upon the question. The Almighty had given to man a wonderful power of mind; and it was that which had enabled him to resist the attacks of disease in all parts of the globe. So long as a man could work hard and keep up warmth of body, he could resist the attacks of disease which might be prevalent. The subject was a most important one, and he should like to see more travellers coming to the meetings of the British Association, to give facts in support of the arguments of our distinguished scientific inquirers.—Mr. HUNT briefly replied to the remarks which had been made, and afterwards received a vote of thanks for his paper, which was referred to the General Committee for the purpose of obtaining its publication.—The proceedings of the day then closed.

SECTION F.—ECONOMIC SCIENCE AND STATISTICS.

Mr. W. NEWMARCH, F.R.S. the president of this section, was yesterday sufficiently recovered to undertake the duties of his office; and the proceedings, consequently, commenced with the learned gentleman's address. He said there was some danger at this time that undue importance should be attached to what had been achieved in physical discovery. Enormous as were our achievements which had been accomplished in railways: beholding, as they did, the prominent effects produced by tubular bridges, ocean steamers, telegraphs, and by rifled cannon, there was some danger—and it was not a small one—lest we should attach excessive and undue importance to the obligations which society owed to these achievements, and those discoveries, great as they were. A glance at the history of the last thirty years would show that there had been in operation economical forces, the effects of which were hardly of less importance. Sound doctrines had been applied to foreign and inland trade, taxation, education, sanitary science, prevention of crime, and the poor laws. Economical science had ceased to be hypothetical, and had become experimental. This, the prominent fact in the history of the last 30 years, was due to the spirit of close scrutiny which had been carried into everything including history, archæology, literature, and politics. It had been mentioned as a reproach to economical science, that it was not purely a science, but partook largely of the nature of an art. He must confess that this was scarcely a reproach, and the remark arose from a hasty view of the real difference between science and art. Science was really a collection of general principles; but all sciences were more or less arts. Astronomy, for example, led to the production of nautical almanacks; and physiology to hospitals, sanitary laws, and precautions against fire. Economic science must be essentially an art, inasmuch as its smallest problems involved human interests, affections, and passions; and the advances which had been made of late years arose from regarding it both as a science and an art. There was a great want of an accurate and convenient term for social science, which would include morality and religion, education, jurisprudence, municipal law, sanitary science, political economy, the fine arts, and the art of government. The Social Science Association had six sections, namely, jurisprudence and amendment of the law, education, punishment and reformation, public health, social economy, and international laws. It was probable that social science would soon imply, technically, political economy, jurisprudence, sanitary science, education, and statistics. He had mentioned statistics, but statistics was not properly a science, like dynamics and chemis

try. Statistics had no body of doctrine, or of general laws, of its own. Its generalisations were of the second order. There were five main divisions, namely, vital statistics, criminal statistics, economical statistics, trade statistics, and taxation statistics. In all these, ultimate units were being gradually established. The annual death rate was almost as important as Dalton's law of definite proportions. It had been established that the death rate in a community of human beings inhabiting a country like our own ought not to exceed 17 in 1,000, and taking their stand upon this, they were able to say that where the annual of death-rate greatly exceeded that figure, there was something wrong. The rate of infant mortality was almost the best test of civilisation. From the plan suggested by the Statistical Congress of last year, they should gradually be able to ascertain what was the real condition, and what was the effect of the social relations pervading different parts of the world. The application of the experimental method pursued during the last 30 years had led to a large modification of the early and economic science in reference to free colonisation, legal interference with labour, currency prices, the nature and operation of rent, and the effects of a large increase of metallic money. As to legal interference with labour, there was no part of of political economy, apparently as clear as that which taught that capitalists and labourers should be left to make their own bargain. Prior to Adam Smith and Ricardo, nearly all such interference by law and custom had been mischievous; and, therefore, experience seemed to be on the side of *laissez faire*, and against guilds, sindics, and government officers. This was true, so long as the labourers were of the adult class, working singly or in small nnmbers, or in families. But it ceased to be true when manufacturers congregated workpeople in large masses, and largely employed women and children, who were only partially free agents. Capitalists said that the limiting the hours of labour would mischievously and fatally discourage capital; and so it would, in the abstract. But there were these qualifying conditions—that capital, depending for its return upon the order and energy of large masses of persons, must take especial care of the physical and moral condition of such persons; and that the efficiency of exertion, even with machinery, did not mean unlimited hours of labour, but skilled efforts during the best selected parts of the day. The experiment had fully answered; and the orderly, educated, and contented labourers of Lancashire were security against foreign competition, and a guarantee of peace. Economic science dealt with six principal classes of questions, namely, the nature of wealth, the exchange of commodities, taxation and finance, currency and banks, wages and division of employment, and interference by the State. The last three only were still in dispute. Formerly with regard to these the *laissez faire* principle seemed to be the general rule; but as society became more complex, it seemed to be clear that the state must in many cases protect individuals. It could not be denied that at present the tendency of civilisation was to deal with rights in masses. The conclusion of the whole matter seemed to be, that as the result of the last 30 years, full as that period had been of scientific achievements, they might justly claim for the services rendered by economic science and statistical inquiry a place in the front rank; that they had now arrived at a kind of intermediate point, at which, after long debate, many of the earlier controversies were finally settled, and from which they might see their way to a higher summit; and that the least doubtful result of their experience had been the discovery that the most solid progress was made by guiding themselves in the main by close observation of facts, and by employing speculative and hypothetical reasoning under the most cautious conditions. But there was a larger moral beyond these results. The last thirty years had been an age of rennaissance, because they had found out that human life had higher ends than employment in incessant labour or devotion to excessive gain; that to accomplish these higher ends they must free themselves bodily and wholly of artificial and false supports, and contest with no mimic earnestness for the honour of the first place among modern civilised states. He did not believe in the New Zealander looking upon the ruins of St. Paul's; but rather looked forward to Windsor Castle becoming a west end mansion, and the villas of the metropolis flourishing on the hills of the White House. No community ever decayed in which the poorer classes could earn a reasonable independence.—The President was loudly cheered on resuming his seat, and a vote of thanks, on the proposition of Lord Monteagle, was cordially passed to him.

PROGRESS OF MANCHESTER AND SALFORD.

Mr. CHADWICK stated, that having been requested by the Committee of Economic Science, at the last meeting of the British Association at Oxford, to prepare a paper on the progress of Manchester and Salford during the 20 years—1840-60—he would consider *seriatim* the increase of population in the principal manufacturing towns in the county; the annual value of property; the proportion of parliamentary representation to persons and property; the trade of the district, with particulars of cotton imports, and exports of manufactured goods; improvements in cotton machinery, wages of the operatives, with a comparative statement of the cost of food and clothing, and facilities for their social, physical, and intellectual advancement; the municipal and local governments of Manchester and Salford, noticing the taxation and local improvements effected within the period indicated. We can give but the merest outline of this elaborate paper, and of the results arrived at by Mr. Chadwick in some 30 or 40 tables. We trust, and believe, that the paper will be published in its entirety, entering so fully as it does into the statistics of our important city and county. Mr. Chadwick exhibited the population of the principal towns in Lancashire at each decennial period from 1801 to 1861, showing an increase in Manchester and Salford from 94,000 in 1801, to 311,000 in 1841, and to 460,000 in 1861; the rate of progress being 47·79 per cent in the last 20 years, and nearly 385 per cent in the last 60 years. Taking the twelve principal towns of the county, during the same period, the increase was from 291,000 in 1801 to 1,417,000 in 1861. Comparing this progress with that of the entire county, and of England and Wales, the rate of increase has been, in the 12 town districts, from 1841 to 1861, 52·53 per cent; and 1801-1861, 386·7 per cent; in the county, in 20 years 45·09 per cent, and in 60 years 260·71 per cent; and in England and Wales, in 20 years, about 26 per cent, and in 60 years 125 per cent. In 1801, the population of Lancashire was 7·68 per cent of the total population of England and Wales, or nearly 1-18th part thereof. In 1861, the per-centage had increased to 12·29, or nearly 1-8th part thereof. Mr. Chadwick then showed, on the authority of Mr. Henry Ashworth, of Bolton, that the total value of property in Lancashire in 1692 was £95,242, and in 1841 £6,192,067, being an increase of 6,300 per cent in a century and a-half—the proportions of the increase being, in the three agricultural portions of the county, 3,500 per cent, and in the three manufacturing hundreds (Blackburn, Salford, and West Derby) 7,000 per cent. The total assessable annual value of property in the county was, in 1860, £10,500,000, being an increase of £4,300,000 in 20 years, or 69·35 per cent. The total assessable annual value of property in England and Wales was, in 1860, £103,500,000; that of Lancashire being, therefore, equal to 10·14 per cent thereof. The essayist then detailed the population and houses in each township of the parish of Manchester and in the parliamentary boroughs of Manchester and Salford in 1851 and 1861, with the per-centage of increase in the 10 years. It appears that, owing to the extension of warehouses, &c. used only in the day time and abandoned at night, the population of the *township* of Manchester has decreased at the rate of 1·04 per cent during the last 10 years, whilst the remaining townships have all increased, Chorlton-on-Medlock being the lowest (25·99 per cent), and Bradford the highest (124·11 per cent), the total increase in the parliamentary borough being 13·09 per cent. The population of the city proper (which does not include Bradford, Newton, and Harpurhey) has increased, from 1851 to 1861, 11·52 per cent. In Salford

(parliamentary and municipal) the total increase in population was 20·33 per cent, detailed thus: Salford township, 11·95; Broughton, 38·72; Pendleton, 46·93; part Pendlebury, 87·46. This rapid increase could only be accounted for on the supposition that the occupations of the people in the manufacturing districts are more congenial and afford better remuneration than agricultural pursuits. Referring to the question of representation, Mr. Chadwick showed that prior to 1832 Manchester, Salford, and many other of the great towns of Lancashire, were unrepresented in Parliament, but that the Reform Bill gave them 26 members (now increased to 27). England and Wales returned 500 members, being one member for £206,925 annual value of property and 40,123 of population; whilst Lancashire, with its 27 members, had only one member for £387,342 value and 91,281 population. Although Lancashire constitutes 12·29 per cent of the population and 10·14 per cent of the annual value of property in England and Wales, the number of its parliamentary representatives is only 5·4 per cent of the number returned for England and the principality. The essayist then passed to a consideration of the great staple trade of the district. His tables under this head were most comprehensive and clear. We can give little more than the totals. Cotton imported into the United Kingdom from 1842 to 1845 inclusive (four years): from the United States, 2,064,128,400 lbs.; all other countries, 608,476,800 lbs.; total imports, 2,672,605,200 lbs. (at 400 lbs. per bale). In 1846 to 1848 (three years): United States, 1,366,796,172 lbs.; other countries, 288,787,878 lbs.; total, 1,655,584,050 lbs. Whilst in the three years ending 1860, the figures were: United States, 1,910,835,648 lbs.; all other countries, 740,434,352 lbs.; total, 3,651,270,000 lbs.—the total imports being, in 1846, 467,000,000 lbs., and in 1860, 1,390,000,000 lbs., being an increase in fourteen years of 197 per cent. Of cotton imported in 1846, the United States supplied 86 per cent, and all other countries 14 per cent; in 1860, the United States, 80¼ per cent, and other countries 19¾ per cent. Next followed a statement of cotton consumed, and manufactured goods produced, in Great Britain in 1830, 1840, 1850, and 1860; which showed 247,000,000 lbs. of raw cotton consumed in 1830, against 1,083,000,000 in 1860; the manufactured goods produced being, in lbs., 182,954,658 in 1830, as against 886,256,345 in 1860. Total manufactured goods in yards, in 1830, 914,773,563; in 1860, 4,431,281,728 yards, or 2,517,774 miles—a quantity which would wrap 100 and a-half times round the globe! Total value of cotton goods produced, upwards of £77,000,000, exceeding by £3,500,000 the total revenue of the kingdom. The difference between the value of cotton manufactured and yarn exported, and the total cotton imports, leaves £16,250,000 as the value of the labour, &c, left in the country from exports of cotton manufactures alone—exceeding our total exports of woollen goods and yarns, and more than double our exports of silk and linen manufactures. As a companion to the foregoing statement, Mr. Chadwick also gave the imports of cotton, wool, silk, hemp, and flax, in various years from 1790 to the present time; annexing a table showing the number of textile factories existing in the United Kingdom in 1856, with other particulars therewith connected. Number of factories, 5,117; spindles, 33,503,580; power looms, 370,195; total persons employed, 682,497. The motive power employed in 1856 appears to have been:—Steam, 137,711 horses; water, 23,724; total horse-power, 161,435. (No later connected returns have been issued.) Number of spindles at work in 1860, 33,862,500, turning off 32lbs. of yarn per spindle per annum. Deducting the exports in yarn, 27,695,511 spindles, or 369,273 looms, remain. Total value of spindles and looms in Great Britain in 1860, £41,247,960. Spindles, 84,656, and looms, 24,685 horse power: total, 109,341; consuming 639,586 tons of coals per year. The increase in spindles in 1860 over 1856 about equals the number required to produce the yarn exported in 1860. Increase in spindles and looms in the four years, 20 per cent. Calculated in the same ratio, number of operatives, 455,055, which, at 9s. 6d. weekly average wages, gives the amount paid in 1860 as £11,239,857 more than was paid in 1856. Our imports of merchandise and bullion amount to £233,626,839; exports, £191,205,421; or a total representing considerably more than one-half of the National Debt. Mr. Chadwick then produced an interesting table showing the exports from the United Kingdom of ten of the principal articles of British and Irish produce for each year from 1846 to 1860. From this it appeared that the export of cotton goods, 1846-60, increased from 1,062,000,000 yards to 2,765,000,000 yards, or 160 per cent. Whilst the *value* of cotton manufactured goods exported in the same period was, in 1846, £17,717,000; and in 1860, £42,141,000; or an increase of 137 per cent. The increase per cent in the other articles referred to was as follows:—

	Quantity.	Value.
Coals and Coke	189	241
Cotton Twist and Yarn	22	25
Iron (cast and wrought)	232	190
Linen Manufactures	64	69
Thread for sewing	84	105
Linen Yarn	60	
Woollen Cloths	97	86
Mixed Stuffs, Flannels, &c	246	152
Total Woollen Manufactures	—	92
Woollen and Worsted Yarn	219	323
Machinery of all kinds	—	243

Spindles in 1840 17,000,000; 1856, 28,000,000; in 1860, 33,000,000. Estimated consumption of cotton in 1840, 9,400,000lbs.; 1856, 17,466,400lbs.; 1860, 18,400,000lbs. Spindles made weekly in 1860, 60,000, or (say) 3,000,000 in the year. Of these, 1,500,000 would be for home; 500,000 for replacement, and 1,000,000 foreign. Increase in the number of spindles in the year, 1,500,000, equivalent to the production of 1,124,000lbs. 32's yarn. The annual increase in cotton supply required to meet the increase of machinery in use in the United Kingdom at this rate would be 3,100 bales, or 1,240,000lbs.; to meet the increase of machinery made in the United Kingdom for home and foreign use (deducting replacement item), 4,687 bales, or 1,874,800lbs. The essayist then dwelt upon the improvements effected in the various classes of cotton and other textile machinery during the last 20 years, noting willow and blowing machinery, and carding engines (increase in production 20 to 25 per cent, saving of labour 20 per cent), drawing frames (increase the same, labour 100 per cent), slubbing and roving frames (increase the same, labour 40 to 45 per cent), spinning and doubling machinery (increase in length of machine 100 per cent, labour 50 per cent), weaving machinery (increase of production in sizing machinery 150 per cent, weaving looms 25 per cent, labour 40 per cent). Mr. Chadwick then presented a comparative statement of the actual increase of work done by cotton, &c., machinery in 1841 and 1861, which we cannot give in detail. It appears, however, that the estimated number of 33,000,000 spindles in 1860 will do as much work as 37,263,600 in 1840; but as there were only about 17,000,000 spindles in 1840 it follows that the increase of the producing power is 119·2 per cent in 20 years. The wages paid in 1844 and 1860 to cotton hands range as follows:—

	s. d.	1844	s. d.		1860
Willow Tenter	8 0	per 72 hrs.	9 0	....	per 60 hrs.
Lap Machine Tenter	12 0	,,	17 0	and 14s.	,,
Strippers and Grinders	12 0	,,	18 0	and 20s.	,,
Drawing Frame Tenter	9 0	,,	11 0	....	,,
Slubbing ,,	9 0	,,	11 6	....	,,
Roving ,,	9 0	,,	11 6	....	,,
Spinner	23 6	,,	29 0	....	,,
Piecer	12 0	,,	13 0	....	,,
Small Piecer	6 6	,,	9 0	....	,,

Mr. Chadwick here contended for the prosperity of Liverpool and other places having been largely dependent upon, and promoted by, the extraordinary extension of the cotton trade of the manufacturing portions of Lancashire; and then summarised his able paper thus far:—Asking (1) whether the increase of population in manufacturing towns was a healthy sign, and likely to continue; (2) whether the trade was not unduly stimulated, or was generally sound and healthy; (3) could we expect a continuance of the present demand for cotton goods, &c., so as to justify the anticipation that the increase will continue in the same proportion as heretofore; and (4) whether a sufficient supply of the raw material of cotton could be found to meet the yearly increasing demand. The essayist then passed to a consideration of the local government of Manchester and

Salford in particular—their corporations, police, sanitary, charitable, provident, educational, and other institutions. He traced the progress of Manchester from 1301, and of the neighbouring borough from 1230, and stated that each was municipally governed by 16 aldermen and 48 councillors. His tables, too, under this head were very elaborate and clear. He showed that in Manchester, in 1839, the assessable value of property was £669,934, and the total of borough rate, £33,515; whilst in 1860 the amounts were £1,441,207 and £68,147 respectively. In Salford, the assessable value of property in 1844 was £161,734, and the borough rate £4,877; whilst in 1860, £346,691 and £10,583 were the respective amounts. An exceedingly interesting table was produced (prepared by Mr. T. Lings), exhibiting the assessments, amount of poor's rate, and the several ways in which the latter has been expended for the last 40 years. This return showed that the annual value of property assessed to the poor's-rate increased from £307,510 in 1820 to £597,921 in 1840, and to £789,203 in 1860; the increase in the value of property being, in the first 20 years (1820-40) 94·44 per cent, and in 1840-60 31·99 per cent. The annual amount in the pound of the poor's-rate on the annual value of the property during such 40 years has ranged from 1s. 4d. to 6s. 8d. The average amount in the pound of the poor's-rate on the assessable value of property during the whole 40 years being 3s. 5½d. Mr. Chadwick then produced a table showing the work done by the Paving, Sewering, and Highways Committee of the Manchester Corporation for the last 30 years. Number of streets and courts paved, flagged, drained, &c. 1,510; length of streets, 60 miles; area flagged and paved, about 205 acres. Main sewers constructed, 88½ miles; cross sewers and eyes, 49 miles; total, about 138 miles. 12,299 syphon-traps have been laid in streets, passages, courts, yards, and houses. [Mr. Chadwick stated, as an addendum to these tables, that the cost of paving and sewering an area of 960,400 yards of streets in Manchester, from 1830 to 1860, had been £311,623. 9s.; whilst in Salford, from 1844 to 1860, 232 streets cost £61,546.] In criminal statistics, the essayist showed the number of persons apprehended in Manchester, and how disposed of, for each year from 1841 to 1860. It appeared that whilst in 1841, with only 317 police officers, there were 2,962 convictions out of 13,345 arrests; in twelve months, 1859-60, with 617 as a police force, 4,900 were convicted out of 7,387 arrests.—Two tables related to the local Courts of Record, showing the actions instituted and their results (in Manchester, 1858-60, total writs issued, 10,475, for £136,188; in Salford, 5,792, for £71,834).—Mr. Chadwick then gave a brief and curious statement of the history, objects, and powers of the court leet for the Hundred of Salford (now nearly obsolete in functions) with its public stocks and other chastisements, and penalties against "eaves-drop in_s, waifs, and irregularities on public commons;" "rogues, vagabonds, and sturdy beggars;" "card and dice playing, and such-like unlawful games." The Salford County Court came in next for a tabulated notice, showing the number of plaints entered to have been as follows: — 1817, 1,754 plaints; 1853, 5,019; 1860, 10,163; amount sued for in 1860, £16,358 The court sat 17 days in 1847, and 47 days in 1860. He also appended a short history of the court and its jurisdiction. The charitable and benevolent institutions of Manchester and Salford were then largely noticed by Mr. Chadwick:— Booth's and the other Salford charities; Manchester Royal Infirmary and Dispensary: in 1840, 19,231 patients, income £16,128; in 1860, 25,437 patients, income £17,079. Lunatic Hospital: in 1840, 74 patients, income £2,629; in 1860, 109 patients, income £6,073. Chorlton-on-Medlock Dispensary: in 1840, 2,095 patients, income £487; in 1860, 2,242 patients, income £366. St. Mary's Hospital: in 1840, 3,455 patients, and £1,121. 7s. 4d. income; in 1860, 4,667 patients, and £2,234. 17s. 5d. income. Eye Hospital: in 1840, 1,510 patients, and £408 income; in 1860, 2,417 patients, and £641 income. Clinical Hospital: total patients to 1860, 4,328; total income, £662. Manchester Institution for Diseases of the Ear: in 1855, 254 patients, £93 income; in 1860, 1,195 patients, £83 income; or £10 less income, and 941 more patients! Dispensary for Sick Children: in 1860, 4,872 patients, income £2,190. Salford Royal Dispensary: in 1850, 4,640 patients, income £2,398; in 1860, 5,732 patients, income £6,101. The statistics of services rendered by the Manchester Fire Brigade in the thirteen years 1848-60, were also noticed by the essayist, showing property saved to the extent of £5,900,364, and destroyed, £851,373. There has been no augmentation of the strength of the brigade, which numbers 51 men. Passing to a consideration of the figures appertaining to the Manchester and Salford Savings' Bank, Mr. Chadwick remarked that habits of forethought and prudence had taken a deep hold on the Lancashire mind, in Manchester especially. The number of depositors in 1840 was 13,453, in 1860, 49,227. Total amount deposited: 1818 to 1840, £1,376,460; from 1840 to 1860, £4,493,065; in 1860 alone, £379,403. Average amount of deposits per annum, 1818-40, £59,846; 1840-60, £224,653. The classification of depositors (as shown in the association's last report) reveals some highly interesting facts. The educational was the last branch noticed by Mr. Chadwick. Manchester (he said) was decidedly great in its Sabbath-school organisation. The gathering in Peel Park, on the occasion of Her Majesty's visit, of nearly 100,000 teachers and children, would not soon be forgotten. The 18th annual report of the Salford Sunday School Union (March, 1860) gives the number of teachers as 674, and scholars 7,766; number of Sunday schools (exclusive of Roman Catholics, of which no complete record was received) in Manchester and Salford, 201, comprising about 90,000 scholars—the afternoon attendance averaging about two-thirds, or 60,000. There are 17 ragged schools, with 402 teachers and 3,678 scholars; 35 night schools, with 1,483 scholars; 15 ragged schools having a penny savings' bank, in which 1,316 children have deposited £278; one night asylum, for destitute children, numbering 300 scholars. In summarising, Mr. Chadwick asked, Have our municipal regulations for preserving order, our sanitary regulations for preserving health, our social regulations for providing healthful means of physical and intellectual enjoyment, our educational regulations for providing instruction and the means of pursuing scientific inquiry, and our various temples for worship been such as could reasonably have been expected from a people so earnestly engaged in trade as the inhabitants of Manchester and the manufacturing towns and districts of Lancashire generally?

An interesting discussion followed, in the course of which Mr. E. Chadwick attacked the sanitary regulations of the place, chiefly on the ground that our ash-pit system had not been abolished. The defectiveness of proper regulations for preserving health was apparent when the mortality was so high as 30 in 1,000.—Mr. W. Horsfall (Garden-street), Mr. D. Chadwick, and others spiritedly replied, enumerating the large sums which had been expended in paving and sewering the streets, in providing water, &c. and attributing the high rate of mortality to the large numbers attracted to the district by its industrial pursuits.—A vote of thanks was passed to Mr. D. Chadwick for his paper.

STRIKES.

Dr. John Watts then read his paper on "Strikes," which he said were amongst the most serious evils to be encountered in the operations of trade, and noticed the importance of a very intimate connection between an employer and his workpeople. The pertinacity and endurance of workpeople on strike would do credit to a good cause, and was proof of their capacity for improvement. He then passed in review some of the principal strikes that have recently taken place, most of which had arisen from dissatisfaction with the amount of wages paid or proposed to be paid. But strikes very seldom achieved the object sought, and it became their duty to enquire if in the few cases where success was possible, that success could be equally secured without resort to this terrible engine of strife and suffering. Examples were then given of eight unsuccessful strikes which represented the amount of wages at £1,082,650, profit lost £210,602, subscriptions £270,617, making a total of £1,563,908. All these strikes have terminated unsuccessfully, so that there has been no compensation for the loss. If these sacrifices were necessary, the endurance of the working-

classes would command admiration, but he could not admit the justice or desirability of a restriction which prevents a parent and an employer from arranging to bring up a youth to a good trade; he could not admit the wisdom of shutting out an efficient workman because he has not been apprenticed, nor could he see why any society should dictate the price of labour. With regard to the establishment of an arbitration court for the settlement of disputes, he suggested that it should be honorary, that the parties to the dispute should each name an equal number of jurymen, that the County Court Judge for the district should be president or umpire, and that the business of the Court should be conducted without lawyers. A bill giving power to the Lords of the Treasury to arrange such courts on petition would restrict them within useful limits. Adverting to the establishment of co-operative societies and manufacturing companies with limited liability, he said the prospects they held out ought to stimulate prudential habits, and so improve the moral tone of working men. The operations of such societies would also supply a sort of wages barometer, showing what amount it is prudent to pay, because the candidates could have but small interest in paying too low a wage, since what is not paid in wages will be in profits, and the amount of profits declared would in steady trade also influence wages for the next half-year. If these societies prospered we might see individual employers in self-defence constituting their workpeople partners in profits. But they had still to stand the test of "hard times" and they could not be expected to pass scatheless through a crisis. He concluded that strikes to restrict the number of workmen in a trade ought not to succeed, and that strikes against improved machinery were attempts to prevent the development of human intellect and the progress of civilisation; and generally he concluded that strikes were wholly injurious, an entire waste of effort, to the extent of not less than a million of pounds sterling annually, or the bread of 38,460, with 4,000 to 5,000 additional who would be required by the profits' loss through strikes. Improvements in the constitution of trade societies would be thought to prevent many strikes, and would secure the support of employers for these societies; that co-operative societies, by teaching prudence, will be useful aids, and that an honorary and voluntary court of arbitration would amicably settle such disputes as might remain.

Mr. E. HILL expressed an opinion that it would be fatal to the masters whenever they attempted to depreciate labour beyond a certain point, and it would be equally fatal to men to try to press them beyond a certain point.—The Rev. W. N. MOLESWORTH proposed a vote of thanks to Dr. Watts, and mentioned that the system of arbitration had been very successful in France. He suggested that Dr. Watts should present his paper in a form that would be of use in introducing a knowledge of this department of political economy as a portion of the curriculum of schools.—Mr. H. Fawcett, Mr. W. H. Bracebridge, Mr. Tautt, Mr. E. Ashworth, Mr. W. Ellis, Mr. H. Ashworth, and Mr. E. Potter also joined in the discussion.—The vote of thanks to Dr. Watts was carried unanimously.

CO-OPERATIVE SOCIETIES.

Mr. E. POTTER read a paper on Co-operation and its Tendencies, of which the following is an abstract:—He pointed out, at starting, the danger of trying to elevate a simple and useful means of thrift into a presumed new mode for the scientific application of labour and capital. After fully discussing the subject, the conclusions he arrived at were:—1. The conclusion I should arrive at, drawn from the opinions I have expressed, would be, that co-operation is sound only when limited to simple and almost unspeculative trading, such as the division of stores, for supplying a provided demand from shareholders, or for institutions and establishments for limited purposes, such as would safely admit the democratic principle of management. 2. That it is inefficient for competitive and therefore speculative commercial undertakings, because it could not, through agents democratically elected and intrusted only with limited responsibility, compete with individual responsibility of greater power. 3. That it would prove weakest during periods of depression, and could not find power of sustention from a multitude of shareholders, of the weaker capitalist class. That it would not supply the power of purchase or expansion during those periods, when the private capitalist invests and expands most profitably. 4. That the more substantial capitalist would be debarred by socialistic rule, which limits the amount of shares to be held, from finding financial and moral support; therefore, the pressure of adversity would come with infinitely greater weight on co-operative associations, than on joint-stock or individual trades. 5. That co-operative experiments, though costly to their supporters, may be valuable to society by affording practical lessons in political economy, and testing the value of, and necessity for forethought and experience; that the greater diffusion of education will not lead to co operation for trading purposes, but to greater self-reliance and competition.

Mr. DANIEL STONE and the Rev. W. N. MOLESWORTH read papers on the same subject, giving, as their illustration, the history of the Rochdale Pioneer Society.

The Rev. W. THORBURN also read a paper, in which he deplored the effects of co-operative societies on Athenæums and other literary institutions.

The section then adjourned.

SECTION G.—MECHANICAL SCIENCE.

The proceedings of this section were resumed in the Peter-street Schoolroom yesterday morning, at eleven o'clock. Amongst those present were Mr. William Fairbairn, president of the Association; Lords Stanley and Wrottesley, Sir William Armstrong, Admiral Sir E. Belcher, the Mayor of Manchester (M. Curtis, Esq.), &c.—Mr J. F. BATEMAN, the president of the section, presided.

REPORT ON STEAM PERFORMANCE.

Mr. SCOTT RUSSELL presented the report of the Committee of the Association appointed to consider the question of steam performance. He said the report was long, and contained tables and statistics of a valuable character, which of course could not be read in the ordinary way. The report would not be intelligible without the statistics, and he therefore thought it better to state briefly to the section the results which had been attained by the Committee during the past year. On the previous day, in that room, a paper was read by Mr. Atherton, chief engineer of Woolwich dockyard, which had a most important bearing on this subject. Mr. Atherton showed that, by a little variation in the shape of a ship, a difference of 32 per cent might be obtained,—that was to say, that between a properly-constructed vessel and an improperly-constructed vessel there was a difference of 32 per cent. Coming from such a quarter, this was a most important admission, because it showed that the principle for which the British Association had been contending twenty years had been at last admitted—(hear, hear),—and the very shape which the experiments instituted by the British Association had demonstrated to be the best,—namely, the hollow water line and the form known as the wave line was the shape now adopted by the Government in the construction of their fastest vessels. The Committee had been most anxious to ascertain for every vessel what was the value of her form as distinct from the power of her engines. He believed that the best and only way to do this was for the Admiralty to make arrangements that after every vessel was launched her screw should be taken out, and that the vessel as a mere hulk should be dragged through the water with a dynamometer attached to the towing rope, so that the amount of resistance offered could be ascertained. The parliamentary committee, united with the committee of this association, had laid this matter before the Admiralty, and they had reason to believe that the board would accede to their request.—(Hear, hear.) The tables which accompanied the report, and which stated the re-

sults of various experiments made with vessels in Her Majesty's navy, were explained by Mr. Scott Russell, and acknowledgment was made of the willingness shown by the Peninsular and Oriental Company, and other mercantile companies to afford every facility to the Committee in prosecuting their experiments. The mercantile service, which had first looked with an eye of jealousy upon those inquiries, now began to see how much they themselves were benefited by them. The returns of the postal service of the French Government had also been placed at the service of the Committee. In conclusion, Mr. Scott Russell gave expression to the regret of the Committee at the loss of their late chairman, Admiral Moorsom, and it was intimated that though the present chairman, the Duke of Sutherland, found his other duties too laborious to enable him to retain that post, he would still continue an active member of the Committee. (Applause.)

Admiral Sir E. Belcher said he would venture to assert that, with the finest model they could produce, the result would depend upon the trim of the ship. One builder might start her by the head, another by the even keel, and a third by the stern. He therefore would suggest that in the experiments to be made by the Committee this point should be taken into consideration. (Hear, hear.) It had been his misfortune once to command the Samarang, admitted to be the worst ship in the navy, which could not sail more than four knots an hour under wind. He took 19 tons of ballast out of her, and beat a famed frigate between the Cape and Java by two days. He afterwards applied for and obtained leave to start a brig stern first, and rig her as he liked, and he believed that was the origin of the wave line.—(Laughter and applause.)

The President here said that he had been informed that it was not customary to discuss reports which would be entered on the minutes of the society. He was not sorry that he had not been told this previously, as it had elicited a valuable suggestion from Sir E. Belcher.

THE LAW OF PATENTS.

The section proceeded to the discussion of the law of patents.

Mr. James Heywood, M.A. F.R.S. read the report of the Committee on the Patent Laws, which was founded upon, and embodied the following resolutions, agreed upon by the Patent Committee in London:—

1. That all applications for grants of letters patent should be subjected to a preliminary investigation before a special tribunal.
2. That such tribunal shall have power to decide on the granting of patents, but it shall be open to inventors to renew their applications notwithstanding previous refusal.
3. That the said tribunal should be formed by a permanent and salaried judge, assisted when necessary by the advice of scientific assessors, and that its sittings should be public.
4. That the same tribunal should have exclusive jurisdiction to try patent causes, subject to a right of appeal.
5. That the jurisdiction of such tribunal should be extended to the trial of all questions of copyright and registration of design.
6. That the Scientific Assessors for the trial of Patent Causes should be five in number (to be chosen from a panel of thirty to be nominated by the Commissioners of Patents), for the adjudication of facts, when deemed necessary by the Judge or demanded by either of the parties.
7. That the right of appeal should be to a Court of the Exchequer Chamber, with a final appeal to the House of Lords.
8. That for the preliminary examination the Assessors (if the Judge requires their assistance) should be two in number, named by the Commissioners of Patents from the existing panel; the decision to rest with the Judge.
9. That the Committee approve of the principle of compelling Patentees to grant licences on terms to be fixed by arbitration or in case the parties shall not agree to such arbitration, then by the proposed tribunal or by an Arbitrator or Arbitrators appointed by the said tribunal.

It would be seen, he said, that the recommendations of the Committee were very important, being no less than the appointment of a special tribunal. He presumed the cost would be defrayed out of the £70,000 which were annually realised by the granting of patents, after payment of the law officers of the Crown and every other official, and a large proportion of which sum was, he believed, applied to the reduction of the taxation of the country.

Mr. Hughes read the resolutions passed at the meeting of the Manchester Patent Law Association, held August 30th, 1860. He remembered that many of the resolutions were not applicable to the present state of the law, having been passed as long ago as 1860; but, on calling a Committee meeting last week, he found that their opinion on the leading points were still unchanged. The resolutions were something similar in effect to those already laid before the meeting.

Sir W. G. Armstrong said that having lately expressed his opinion of the inexpediency of a law of patents for inventions, he intended to state the reasons which had led him to this conclusion. Some years ago, he was consulted by the late Mr. Brunel with respect to the construction of a gun, the interior lined with wire. In theory the idea was sound, but there were practical difficulties to be overcome. He agreed to endeavour to work it out, but they found that a patent had been taken out for this idea some few weeks before. Now, with great respect to the gentleman who had obtained the monopoly of the idea, he must remark that had Mr. Brunel and himself been permitted to investigate the subject, the world would have had a double chance of seeing such a gun perfected.—(Hear, hear.) As it was, the practical difficulties still remained unremoved. This was not an isolated case. Similarity of circumstances naturally suggested similar ideas to different persons, and he who happened to get first to the patent office obtained a monopoly of the conception. In 1859, the Great Northern Railway proposed to adopt a wrought iron wheel welded in a particular form. He with other engineers sent in patterns, the contracts were entered into of the wheels sent in, and then a person came forward and produced a patent, dated 1839, which had been left in abeyance all that time, until some one had succeeded in making it practical. This instance disclosed the vice which ran through the whole of the patent system.—(Applause.) The number of patents was becoming perfectly frightful—(hear, hear)—and probably not one in twenty was in use or was ever likely to be, unless as in the case just mentioned, they were made practical by the labours of others. As an argument in favour of patents it was said that the invention of a man's mind was his property. But how could a man say that a certain invention was his property or that the same idea had not occurred to some one else years ago? And if he had a right to this invention as his property why should it be taken from him at the end of 14 years? He believed the efficacy of these patent laws for the protection of the invention was much overrated, and as far as himself was concerned he believed he should have been in just as good a position now without the patent laws as with them. Even without a patent the inventor had many advantages over others who might be disposed to make his goods. He might be supposed to have got the start of all competitors in the appliances necessary to produce the article, and he would have earned a name and the public had great faith in names. The patent system in the case of small inventions was vexatious to the public, and in the case of great inventions was often inefficient in its results. He admitted the system was capable of improvement, but in his opinion the only remedy for the evils which now existed was the total abolition of the patent laws. Sir William Armstrong referred to the remark of the President of the Association in his opening address, that the complaint about the monopoly of the patent laws was made by those who had done the least to benefit their country by inventions;

and he complained that in an address of that nature anything savouring of the personal should have been introduced.

Mr. T. WEBSTER, F.R.S. followed with a paper in which he took the opposite view of the question. He contended that to deny that protection to intellectual labour which was accorded to manual labour was to place the intellect below the hand. That evils at present existed he admitted, but he believed they were due more to the mal-administration of the present system than to the defects of the system itself.—(Applause.)—Mr. Webster also read a paper contributed by Mr. R. A. Macfie, of Liverpool, on patents considered internationally, in which suggestions were made that after three years the inventor's absolute monopoly should give place to a right of granting licences, and that arrangements should be made between the states of Europe and America for purchasing patents, and presenting them to the world.—Mr. SPENCE followed with a lengthy paper on Patent Tribunals.

Lord WROTTESLEY, before the discussion of these papers was entered upon, suggested that a distinction should be drawn between evils which could be remedied by legislation and those which could not, and that the discussion should be confined to the former.—(Hear, hear.)

Mr. W. FAIRBAIRN, in reply to the concluding observations of Sir William Armstrong, assured that gentleman that personalities were a commodity he never dealt in.—(Hear, hear.) He regretted if he had said anything which had given offence to Sir William Armstrong; but he maintained that the views he had then set forth were correct. He thought there could be no greater robbery than for one man to deprive another of the results of his intellectual labours.

Mr. GROVES, in a long and able address, combated the arguments of Sir William Armstrong, and discussed the resolutions passed by the Committee. He suggested that, instead of one never-varying term of fourteen years, patents should be granted for terms of three, five or ten years, according to the value of the invention and the amount of labour and capital expended upon its production.

The MAYOR of Manchester said that the great objects of the patent laws were to give a stimulus to inventors, and he believed there were many valuable inventions which but for the protection afforded by the patent laws, would never have been made known to the world. He instanced the improvements in the spinning trade by the firm of which he was a member, mentioning that at least £20,000 was expended in bringing those improvements to a completion, and said he would tell them distinctly, as a practical man, that had it not been for the protection of the patent laws they would never have entered upon the matter at all.—(Hear, hear.) What would have been the result supposing they had done so, and there had been no patent law in existence? Why, that any one might have pirated the results of their labours and been in a better position than they were, because whilst they would have spent £20,000 he would have spent nothing.—(Hear, hear.) People might talk about patriotism, and the honour of being the author of great inventions, and all that sort of thing; but they might depend upon it that the main question with inventors was—"How can we put the most money into our own coffers?" (Laughter, and "hear, hear".) At the same time, they knew that they could not benefit themselves without benefitting the state. He approved of the resolution of the Committee recommending the appointment of a special tribunal for the consideration of patent cases; but the scheme for establishing a preliminary tribunal he considered would be productive of much harm.—(Applause.)

Captain BLAKELY, R.A. said he perfectly agreed with Sir William Armstrong that patents were an evil both to the inventor and the public. But Sir W. Armstrong had rather shaken his opinion by the admission that two such eminent men as Mr. Brunel and himself had paused in a series of experiments which might have been of great advantage to the country, apparently because they could not hope to reap the whole reward. He might as well state that he was the inventor of the wire lined gun, to which allusion had been made, and that all the royalty he had asked was *nil* during the time the experiments were in progress, and one shilling per cwt. after the invention had been perfected.

The Rt. Hon. JOS. NAPIER said he should take a broad and fundamental objection to Sir W. Armstrong's proposition. The law recognised a property in the productions of intellect as well as in the material labours of the hand, and he contended that they would lower the whole character of the law by withdrawing its protection from the products of the mind.—(Hear, hear.) He considered that every man had a right to the labour of his brain. It was the only property he (Mr. Napier) had ever had—(laughter, and applause),—and possibly for that reason he was the more tenacious of it. Allusion had been made to the present mode of "investigating" the claims for patents by the law officers of the Crown. Now, he had had the honour of being an Attorney General, and was a granter of patents. But he never knew anything about them.—(Laughter.) His clerk, who was a very intelligent man, managed the whole business, and he had nothing to do but to sign the parchment. Then the Solicitor General in the second court—which was generally a very amicable court—(laughter),—seeing that his General had signed the patent, put his signature to it also, and thus the patent was granted. He looked upon the whole system as a tax upon the inventive intellect of the country for the support of the law officers of the Crown, whose other duties left them no time to make any such investigations as were required.—(Applause). He thought patents ought not to be granted without proper investigation and inquiry, and he agreed with the recommendations of the Committee.—(Applause).

Lord STANLEY spoke of the impossibility of carrying out any system of Government rewards for inventions, as had been incidentally suggested by Sir William Armstrong. Then came the question, if this were impracticable, how were inventors to be rewarded? It was no answer to this question to say that a man would have the honour of his invention. True, there were some inventions which brought much honour to the inventor. Sir W. Armstrong was a case in point; but there were other useful inventions from which little or no honour accrued to their originator. Besides, honour would not support a man.—(Hear, hear.) He saw no better way open than the present system of allowing the inventor to be remunerated by his own invention.—(Applause.) He thought there was great force in the argument which had been used by Mr. Groves, that if you did away with the patent laws you would bring back all the evils of the old system of keeping inventions secret—(hear, hear) which was a great disadvantage to the public as well as to the inventor. He could not but think it was too much the practice for patents to be taken out merely for ideas, for it was a question to be seriously considered, whether a patent should be allowed to be taken out as easily as at present. The recommendations he had to offer were these that after the patentee had had the monopoly of his invention for a certain time, he should be compelled by law to grant licences for the use of his invention by other persons; that patents left idle for a certain length of time, in the way complained of by Sir William Armstrong, should be forfeited, and that a preliminary inquiry, as suggested by the Committee, should be made by competent persons to ascertain whether an invention was new or not.—(Applause.)

Mr. THEOPHILUS ASTON said there was one point which had not been touched upon, and that was the important service which the patent often rendered to poor inventors in enabling them to raise the capital wherewith to bring out their inventions. He congratulated Sir W. Armstrong on the fact that he had discovered a plan of working an invention far superior to taking advantage of the law of patent, and he quoted from the blue book recently issued the terms on which Sir William Armstrong had surren-

dered his invention to the country. He stated that it was provided that the guns should only be made at the works at Elswick, in which Sir William Armstrong was a partner, and at the Government establishment at Woolwich. £50,000 had been paid down to Sir William Armstrong's partners to enable them to erect works for the manufacture of Armstrong guns. It was provided that the cost of experiments should be borne by the Government; and, in addition to all this, there was a clause securing to Sir William Armstrong a right of compensation in case of the agreement being terminated by the Government. Mr. Aston was proceeding with further observations, when

Mr. SCOTT RUSSELL, (who had taken the chair in the absence of Mr. Bateman,) remarked that he thought enough had been said to show the meeting the point to which Mr. Aston's remarks were evidently directed—namely, that in this matter Sir William Armstrong might have a personal bias.

Mr. Archibald Smith and Mr. Winkworth supported the view taken by Sir William Armstrong of the desirability of the abolition of the patent laws. Mr. Norman and Mr. R. Roberts spoke on the opposite side.

Sir WILLIAM ARMSTRONG, on rising to reply, was received with applause. He said he had scarcely expected when he came to Manchester that he should be put upon his defence—(laughter)—and therefore he was taken somewhat unprepared, and had not time to get up his case.—The CHAIRMAN remarked that there was no necessity for Sir William Armstrong to stand upon his defence at that meeting, but of course this was a matter which must be left to Sir William's own discretion.—Mr. ASTON explained that he had made no charge against Sir William Armstrong.

Sir W. ARMSTRONG said it had been implied by Mr. Aston, that by a system of scheming and dodging, he had placed himself in a much better position, than if he had taken advantage of the patent laws. The facts were these. He offered his invention to the Government, and they accepted it; up to that time the manufacture had been exclusively carried on at Elswick, and it might be supposed that that there was no person so well fitted to instruct the Government in the manufacture of the rifled ordnance as himself. The Government tendered to him a large pecuniary reward which he declined. It was then proposed that he should enter the service of the Government as engineer and rifled ordnance superintendent. He said at the time that he would not undertake the superintendence of more manufactories than the ones at Elswick and Woolwich. They agreed to give him £2,000 a year, and up to the present time, this was all he had received, so he did not think the Government would complain. — (Applause.) He was not a member of the Elswick Rifle Company, as stated.—(Hear, hear.) It was open to him to join the company, but he should not do so without terminating his present arrangement with the Government, and starting afresh.—(Applause.) With regard to the £50,000, he knew of nothing of the kind.—(Applause.) There was a mortgage of £40,000 upon the Elswick works held by the Government, but that was only as a security for the fulfilment of the contracts which were entered into with the country.—(Renewed applause.) He was satisfied that were he free from any engagement he could make much more money than he had ever received by offering his invention to foreign powers. Sir W. Armstrong concluded by expressing his concurrence in the opinion expressed by one of the speakers, that the country was not yet ripe for the total abolition of the patent law, and his willingness to acquiesce in any measure for the amelioration and improvement of the present legislation. He was warmly applauded on resuming his seat.

Mr. SCOTT RUSSELL remarked he should not let his position of Chairman shelter him from making the declaration that he belonged to the weaker side and inclined to the views advocated by Sir W. Armstrong.—(Hear, hear.) The inference he drew from the long and interesting discussion which had taken place was that the manufacturers of Manchester and the Mechanical Section of the British Association would continue to agitate this question with great energy until the grievances arising from the present utterly inefficacious patent laws should either be removed by the reformation of those laws, or by the total abolition of the patent laws and the institution of the patent laws, and the substitution of some tribunal for rewarding inventors—this last he did not expect until they arrived in Utopia. (Laughter and applause). He had no doubt the important discussion which had taken place, would eventually result in some serious changes in the laws as affecting patents. (Applause).

The section then adjourned about half-past four o'clock.

PROFESSOR MILLER'S LECTURE ON SPECTRUM ANALYSIS.

In the evening, the Concert Hall was filled with a brilliant audience, assembled to hear a lecture from Professor Miller, "On Spectrum Analysis." The proceedings commenced shortly after eight o'clock, when Mr. William Fairbairn, the president of the Association, took the chair. There were present on the platform:—Lord Wrottesley, Lord Stanley, General Sabine, the Rev. Dr. Robinson, Rev. E. V. Hopkins, the newly-appointed general secretary, Rev. A. Vernon Harcourt, &c. After a few introductory observations by the President,

Professor MILLER said that the subject which the Council had requested him to bring before them on the present occasion was one which had, perhaps, among the scientific gentlemen of the present time, attracted as large a share of popular attention as any that could be named. It appealed to the imagination so powerfully; it revealed to us matters of investigation, which, like the telescope, made known to us what was passing in distant worlds, bringing before us not only those particular changes which were going on in the bodies which composed our solar system, but it appeared further to reveal something of the nature of the more distant starry world. Not only did it thus, like the telescope, make known distant objects, but like the microscope, it revealed bodies and substances so minute that would defy any other mode of investigation to make known, and had to the present time defied all the sources of chemical analysis. He would put before them, in as brief a manner as possible, the successive steps by which this discovery had been developed. Like all other great discoveries, it was not the work of a single individual. It was a work in which they were proud to say their own countrymen had borne a prominent part; and it was especially fitting that this subject should occupy the attention of the British Association as many of the members of the body had laid the foundation of their knowledge on that point. First upon the list of names stood that of Newton. In 1701 his great work on optics was given to the public. The spectrum, as Newton saw it, he proposed to exhibit. The spectrum was perhaps the most glorious sight the eye could behold, the beams of white light broken into colours defied description, and could only be appreciated by those who saw it. Newton, and all the followers of Newton up to the commencement of the present century allowed light to pass through a circular aperture, and this exerted an important influence upon the phenomena observed. The spectrum of the sun presented certain black bands, which were observed by Workaston; but he did not further pursue the investigation. In 1814 a distinguised German philosopher Fraunhofer, examined with a telescope the ray of light after it had thus passed through the prism, and found he obtained a series of black lines. These lines occurred whatever was the material used in the prisms. Having exhibited the spectrum of Newton, the lecturer proceeded by a series of experiments to illustrate the various steps taken in these observations. Fraunhofer examined the light of various fixed stars and found that although in the sun's light the black lines always occupied

a definite position in the spectrum, the black lines in the spectrum of the rays produced by the stars were not always in the same position. This had proved an invaluable fact to opticians in reference to refractive power. Other lights also exhibited a different system of lines. If they heated up any substance until it gave out light, as all solid bodies would if sufficiently heated, these solid bodies would produce an uninterrupted spectrum; but if examined by artificial light there was a broken spectrum, it being crossed by bright lines. Sir David Brewster, one of the most distinguished philosophers of the day, and who, he was glad to say, was amongst them, was the first to throw any light on the cause of these lines. He observed that if the sun's rays were horizontal they had to pass through a stratum of 200 miles or more of atmospheric air at its greatest density; if the rays were vertical they had to pass through one stratum of continually decreasing density. It would be observed that when the sun's rays were horizontal certain portions were absorbed. Hence, it appeared to be certain that particular rays were caused or deepened by the absorptive action of the earth's atmosphere. In 1832, at one of the meeetings of this body, Sir David Brewster exhibited an experiment, in which he had found that red vapours produced by one of the oxides nitrogen had a remarkable power on the sun's rays. In 1822, Herschell made a series of observations upon coloured lights; and he found that by putting certain salts into the flame of burning bodies those flames became coloured. But it was to Mr. Talbot they owed the suggestion by which these observations could be turned to account for chemical analysis. The colours, in some instances, were so closely allied when viewed by the naked eye that nothing could be seen to distinguish them; but the moment they were put through the prism there was a marked and striking difference. Lithia produced a beautiful red colour to the flame; stronchia did the same; but the difference through the prism was very apparent. Mr. Wheatstone gave the first impulse to inquiries into the spectra of electric light in 1835. He showed a mass of various spectra produced by sparks taken from different metals. Each metal had its own peculiar spark, whether the voltaic or magnetic or common electrical machine was used as the volatising power. He further showed that it was not due to the burning of the metal, for he had experimented in a vessel from which the air was exhausted, and instead of air had used carbonate acid gas, and found the same result to follow. Professor Miller continued his experiments by showing the effects of lead and tin, and said that the presence of other metals might be detected. Each metal had its own spectrum. Looking at the spectrum, they knew what metals they were handling. The same was the case with different gases, of which the most impalpable trace could be detected. Thus they were able, by the ines in the solar and stellar spectra to ascertain the presence in these bodies of particular metals and acids. Using the spectrum microscopically for analytical purposes Professor Bunsen discovered in the residue of a certain spring, a set of lines he had never seen before, and which existed only to the extent of three grains to the ton. This he called cœsium, from its beautiful blue colour. Rubidium had been discovered in a similar manner. Having given specimens of these spectra, the Professor concluded by thanking those gentlemen who had assisted him to make the experiments.

A vote of thanks to the Lecturer was proposed by the Rev. Dr. Robinson, seconded by the Rev. E. W. Hopkins, and carried amid much acclamation

SATURDAY, SEP. 7

The several sections continued their meetings to-day. There was also an excursion to the colliery of Messrs. Knowles, of Clifton; and during the afternoon some members of the Chemical Section proceeded to Warrington, and inspected the works of Mr. Dale.

PROCEEDINGS OF THE SECTIONS.

SECTION A.—MATHEMATICAL & PHYSICAL SCIENCE.

The President, Professor AIRY, Astronomer Royal took the chair at eleven o'clock.

Mr. G. T. STONEY read a paper, "On the amount of direct magnetic effect of the sun or moon upon instruments at the earth's surface."

The PRESIDENT next made a communication, "On the laws of the principal diurnal inequalities, solar and lunar of terrestrial magnetic force, as deduced from ten years observations at Greenwich, and on their apparent causes." He first directed his observations to the solar magnetic diurnal inequalities, remarking at the outset that it was an admitted theory that if all the compasses in the world were set due north, they would not point due north, but magnetic north. The position of the magnetic needle was not constant from day to day, much less from year to year. After remarking that hitherto no system had been in operation by which a register of magnetic inequalities could be kept, he said that very recently a proposal had been under consideration for indicating these magnetic inequalities by means of a photographic self-acting register. Having explained the process by which it was proposed to carry this photographic self-acting register into effect, and shown that under its operation a constant registration of the disturbances in magnetism during the day would be secured, he observed that, having accomplished this, they would be enabled to ascertain what was the disturbing force that acted on the magnet. In pursuing this theory through a number of years, they arrived at some very curious results indeed, and there were some of them of which they could give no account or explanation. One of these results was that it had been ascertained that the amount of daily disturbing force at different hours of the day varied very much in different years. For instance, in the year 1848, the disturbing force was nearly double that of 1857. It was very regular in the latter period, but varied very much indeed in the former. There was another fact which had been ascertained in reference to these disturbing influences, which it might be interesting to the section to know. It was this—that it had been discovered that the diurnal disturbances of the magnet were very much greater in the months of June and July than they were in the months of November and December. After some further observations, he proceeded to draw the attention of the section to the laws of these disturbing forces. With the assistance of maps and diagrams which were exhibited, he entered into an elaborate explanation of the subject, and concluded by saying he was perfectly convinced, in his own mind, that the main cause of these diurnal inequalities and disturbances of the magnetic needle was due to the radiation of the sun on the water of the North Atlantic, and which acted with considerable power upon the land.

Sir DAVID BREWSTER (who had taken the chair during the observations of the President), said that the Astronomer Royal had explained this most difficult question, as indeed he did everything which he undertook, in the clearest manner possible. He might have explained the various points technically, which would, perhaps, have been understood by the few who took an especial interest in the subject, but to the section generally it would not have been plain. But the Astronomer Royal, instead of speaking upon the matter technically, had explained it popularly, which was a mark of his great intellectual powers, and showed, further, that he did not consider it a condescension on his part.

Some discussion having taken place on the subject,

The PRESIDENT next proceeded to explain the lunar terrestrial variations and inequalities, observing that no action of the moon, as an independent magnet, was sufficient to cause these variations, and he had, therefore, arrived at the conclusion that the earth acting upon the moon accounted for these lunar disturbances.

The thanks of the section having been given to the President for the communications he had made, he next proceeded to make some observations "On Spontaneous Terrestrial Galvanic Currents." It being now a well ascertained fact that spontaneous galvanic currents have in several instances prevented the working of the telegraphic wires, the matter had become one of so much importance that he had felt the necessity of steps being taken to ascertain the exact cause of these disturbing influences. With this view he had placed himself in communication with the telegraph companies, but had not been able to obtain much information from them, probably in consequence of their not having the leisure to note down observations on the effects produced on the telegraphic wires. His wish was to have a constant registration of the effect of these galvanic currents, at the Royal Observatory, and he believed that all that was required to ascertain the causes of these spontaneous disturbances was the laying down of an insulated wire. The Government had acceded to his proposal, and he thought it his duty to state that on the part of the Board of Visitors, there was the most anxious wish expressed, that the object he had in view should be carried out. In all these instances the Government had acted towards him with the greatest liberality. He (the President) had been in communication with Dr. Lamont, of Munich, and had received the following communications from him on the subject, which he had thought it desirable to have printed for the members of the Association, but not necessarily for circulation amongst the public generally. In one of his communications Dr. Lamont said "Since the beginning of last year I have been occupied with the investigation of the electric currents observed in telegraph wires, and have obtained various results; the most remarkable of which is this, that electric currents, or, as they may be more properly termed, electric waves, varying in direction and intensity, are constantly passing at the surface of the earth, and that these waves correspond perfectly with the variations of terrestrial magnetism; a wave directed from north to south producing an increase of westerly declination, and a wave directed from east to west producing an increase of horizontal force. I have employed wires of different lengths, and metallic discs of different sizes and at different depths underground—in all cases the currents are the same, but their intensity depends on the size of the discs and the length of the wires, or rather the distance at which the discs are placed from each other. A distance of 400 feet is sufficient if the discs are large enough. To show the effects satisfactorily, the instruments must be of a peculiar construction; ordinary galvanometers and magnetometers will not answer; besides, various other conditions are to be observed."

And in another communication he stated that "The currents observed in telegraph lines are due partly to the agency of chemical causes (oxydation of the discs and other parts of circuits), partly to thermal causes (thermo-electricity, expansion, &c.), partly to terrestrial electricity. The variations of terrestrial electricity can only be obtained while the chemical and thermal causes remain constant. The effect of the chemical causes changes very slowly: the effect of the thermal causes can be considered as constant only in calm weather, and for very short intervals of time (say two or three minutes), when the wires are of moderate length and suspended in the air, for longer intervals if underground. I believe that lines above 1,000 feet in length, if not underground, are of no use for the investigation of terrestrial electricity, because under all atmospheric circumstances the disturbances produced by thermo-electric currents will be too great." It appeared to him, with very great submission to Dr. Lamont, that they need not, necessarily, be bound or restricted to the limits which he suggested. As the distburbances affected long lines of telegraphic wires, it appeared to him that their attention ought more particularly to be directed to these long lines. He had brought the matter before the section with the view of inviting discussion upon it. He should be happy to hear from the section whether they were prepared to adopt the views of Dr. Lamont or his own, which, he might say he had now power from Government to carry out. He should be glad if any gentleman would throw out suggestions upon the subject. He would not bind himself to act upon them, but at the same time they should have his best attention.—Some discussion having taken place on the subject, Professor HENNESSEY, F.R.S. submitted a paper "On a probable cause for the observed diurnal variation of dip and declination." He said that the paper which he was about to submit to the section might almost be regarded as a continuation of what had already been said by the Astronomer Royal. When they turned their attention to this subject it became important to remember that the magnetic actions in the atmosphere resulted from differences of temperature between contiguous masses, rather than from absolute amounts of temperature. This subject had already been largely treated by Mr. Faraday; but there was one important point which appeared not to have been hitherto touched. He referred to those differences between minute masses of air resulting from the manner in which the lower strata of the atmosphere acquired their heat by connection. This kind of aerial connection was dependent upon sunshine.

The Rev. E. HINCKS read a long paper "On the quantity of the acceleration of the moon's mean motion, as indicated by the records of certain ancient eclipses." He said that the question which he proposed to consider was whether the acceleration of the moon's mean motion with reference to the sun and stars was 12 deg. or 18 deg. multiplied, or only about one-third of that quantity. He contended that, as stated by Mr. Hanson, the indications of the acceleration of the moon's mean motion was only 9 deg. instead of 12 deg. Here, however, he was met by the Astronomer Royal, who appealed to ancient eclipses to show that it was more than Dr. Hanson gave, and that it should be augmented to 13 deg. instead of being diminished to 9 deg. It would be necessary for him, in the first place, to show that the arguments were inconclusive. In fact, they were not entitled to weigh a feather in the scale. Whilst endeavouring to show the fallacy of the Astronomer Royal's reasoning, he would only observe that while he differed from him on this point, he entertained the highest respect for him personally, and fully appreciated the great services which he had rendered to astronomical science. After going at great length into the subject, in the course of which the views of the Astronomer Royal were freely canvassed, the paper concluded by the observation that this was a question as to a matter of fact. It involved no question of theory. He by no means expected or wished that the statements which he had made should be taken on trust, but, he wished that these ancient eclipses should not be ignored, as they had been by the Astromomer Royal, as unworthy to be taken into account in conjunction with alleged eclipses of the sun, the records of which were fanciful, and, as he was persuaded, false. The Astronomer Royal relied upon four eclipses, as sustaining his view. One of the four he (Mr. Hincks) admitted to be a genuine record; the other he rejected as unreal, pretended, imaginary records.

The CHAIRMAN said that as the paper would, no doubt, be printed with the Proceedings, the Astronomer Royal (who had been compelled to leave to fulfil another engagement) would have an opportunity of considering it, and answering it if he thought it necessary.

DEVIATIONS OF THE COMPASS.

The communications next submitted were two papers by Archibald Smith, Esq. F.R.S. and F. J. Evans, Esq. R.N. superintendent of the compass department of Her Majesty's navy, "On the effect produced on the deviations of the compass by the length and arrangement of the compass needles." Mr. SMITH said: When the deviations of the compass, caused by the iron of a ship are corrected by magnets of soft iron, in the way long ago proposed by the Astronomer Royal, the correction is perfect so long as the distance of the correctors from the compass bears a considerable proportion to the length of the needle; but where, from the large amount of deviation in some iron ships, or from the great length of the needle used, this condition is altered, a new kind of deviation is introduced which cannot be corrected in the usual way. This was observed in the compass of the Great Eastern, and experiments made by Mr. Evans showed its cause. He observed, however, that the same error was not introduced, when, instead of single-needle compasses, Admiralty compasses with two bars each placed 30 deg. from the central line, or four bars placed two and two at 15 and 45 deg. from the central line, were used. And it was found in applying mathematical calculation that this arrangement of needles, which had been introduced and long used in the navy as the best, on other grounds completely corrected the error in question. The second part of the communication was to the effect that the part of the deviation, known as the "quadrantal," might be completely corrected by the use of two compasses placed side by side, as in the old double binnacle compasses, instead of masses of soft iron—Admiralty cards being used in this case also, instead of the single-needle card.

THE WARRIOR AND HER COMPASSES.

Mr. F. J. EVANS next communicated the following paper on the same subject, which was listened to with the greatest attention by the section. He said:—It may be considered interesting to the meeting to receive a brief notice of the magnetism of the first of the great iron war-ships of the day, the Warrior, and of the disposition of her compasses. There is but little novelty in the arrangement of those on the upper deck, excepting that it has been deemed desirable to furnish two standard compasses, from the unavoidable proximity of the after one to a new feature, which, from the special character of the ship, has been introduced, namely, an iron-cased tower of rather considerable dimensions for holding riflemen, and of sufficient thickness to withstand the fire of heavy ordnance. This tower is placed on the quarter deck, in the neighbourhood of the steering wheel. The magnetic character of the ship, as developed by the two compasses, before the rifle tower was fixed, is quite in accordance with the received principles, as due to the direction of the ship's head, in building, with reference to the magnetic meridian. The foremost compass, which is about one-third of the ship's length from the bow, had, on the 10th of August last, a maximum declination of 16°, and the after compass, which is about one third of the ship's length from the stern, a maximum declination of 31°, the ship being built within about 3° of the magnetic meridian (head North, 3 deg. east) and the points of no declination consequently at north and south. The declination of the after compass had lessened 6 deg. on the 24th of August, at which time the casing of the iron rifle tower had com-

menced. But it is not to these points I would chiefly now direct your attention, but to certain necessities, arising from the novel structure of the ship, demanding, in so far as the compasses are concerned, serious attention. In the fighting ships of what may now be termed a past generation, we did not seek for or expect invulnerability. In 1861 we demand nothing less, and "more iron" is the cry. It is clear from these new conditions that one compass at least, on which the ultimate safety of the ship may depend, should be equally protected from the fire of the enemy, in the event, which would most likely happen, of every thing standing on the upper deck being swept away by the fire of the enemy. For the management of the Warrior, under this probable contingency, an additional steerage wheel has been fitted within the great armour-protected space on the main deck. This space, I need scarcely inform you, is cut off from the ends of the vessel by enormous iron bulk heads. We are thus obliged, without reference to choice of position, to place a compass near this steering wheel on the main deck, and surrounded by iron of massive character on every side, and above as well as below. Under these circumstances we could not but expect deviations of a large value, and particularly from the enormous amount of horizontally placed iron from the two iron decks and their beams, a large quadrantal deviation. From the few observations I have been enabled to make, owing to the constant progress of the fittings, this quadrantal deviation on the main deck is about 10°, nearly trebling in value the quantities I have had to deal with in the other iron ships of the royal navy. It must be familiar to those who have practically dealt with the subject of correcting ship's compasses by the antagonistic influences of magnets and soft iron, that 10° of quadrantal deviation is an enormous amount to deal with, and that the employment of soft iron correctors which might be usefully employed in the smaller values, becomes open to grave objections for the larger ones. I have adopted, for the Warrior's main deck compasses, the plan therefore alluded to by Mr. A. Smith, namely the compass cards on Mr. Smith's plan, and two compasses so placed close together as to destroy, by their mutual action, this 10° of quadrantal deviation, and correcting the polar magnet, or semicircular deviation, by *one* system of magnets placed in a vertical plane below, and in a central line between, the two compasses, so that both are equally corrected at the same time. At the time of my observations this semicircular deviation was nearly three and a half points, or nearly 40 deg. at the maximum. I venture to hope that we have by this method overcome the more serious difficulties of disembarrassing the unfortunate compass which is now so tortured in its action by the never-ending introduction of iron of all shapes, sizes, and quality around it; but I feel that increasing vigilance is more than ever required in watching the compass under these conditions, and that the subtle agencies of the forces we employ will elude the control of unskilled hands. The greatest difficulties I have experienced in making certain preliminary experiments, and what must happen practically in dealing with large compass deviations, are those due to delicacy of manipulation and workmanship; for example, the lubber lines of the compasses must be placed exactly parrallel, and exactly in the fore and aft lines of the ship; the centres of the compasses must be exactly in a line at right angles to the head of the ship; the adjusting magnets must follow the same accuracy of arrangement; and we are thus, day by day, approaching to the necessity of being forced to expend upon an instrument, so common, but so valuable, and which unfortunately seamen in general, and, I may venture to add, iron ship builders in particular, often treat so lightly, the same rigid accuracy of fittings and attention that are required with the more delicate instruments of the observatory. I may add that within the last few days I have been informed that the steering compasses of La Gloire (the Warrior of France) are placed within a similar rifle tower on the upper deck. I am further informed by M. Darondeau, who holds, with respect to the French imperial navy, a somewhat analogous position to my own in the royal navy of this country, that this is an unadvisable arrangement. In concluding these brief remarks, I cannot but convey to the meeting the deep debt that the seamen of all nations owe to the President for his long and patient investigation, on their behalf, of the management of the mariner's compass under difficulties. To him we are indebted for the first practical rules on the subject, and, however opinions may have varied as to the uses of correcting magnets under the old condition of things, there can be no doubt that in the case of the Warrior's main-deck compass, this system, in its main features, becomes an absolute necessity.

The CHAIRMAN said that the importance of the papers just submitted could not be over-rated at the present time, when iron ships for both naval and commercial purposes were becoming so general. The section had been fortunate in having before them two gentlemen—the one by his great mathematical attainments, and the other by his practical knowledge and skill, who were so well able to speak upon the subject.

A vote of thanks to both gentlemen was carried by acclamation.

The Rev. H. LLOYD read a paper "On the secular changes of terrestrial magnetism, and their connection with disturbances;" Mr. SILVESTER "On the involution of axes or rotation;" Mr. CAYLEY "On curves of the third order;" and M. BIERENS DE HAAN "On definite integrals," after which the section adjourned, the subjects remaining to be taken this morning.

SECTION B.—CHEMICAL SCIENCE.

The meeting of this section was held at Owens College. The President, Professor W. A. MILLER, M.D. F.R.S. took the chair a few minutes after eleven o'clock. The President stated that through the kindness of Mr. Dale, the members would have the opportunity of visiting his works at Warrington in the afternoon.

ATMOSPHERIC OZONE.

Doctor Moffat read a paper "On atmospheric ozone," of which we give a summary. He said: In 1848, a communication of mine on atmospheric ozone was read at the meeting of the British Association, at Swansea. From that time the subject has had my constant attention; and the results in this paper have been deduced from the observations of ten years. As a rule the observations were recorded twice daily, sometimes oftener. The readings of the barometer, thermometer, and hygrometer, the directions of the wind, the amount and class of cloud, were recorded daily at ten a.m. and four p.m. The amount of rain, falls of hail, snow, and sleet, the prevalence of fog, and all atmospheric conditions and phenomena were registered as they occurred. The discussion of these observations affords the following results:—The mean daily quantity of ozone is greater with readings of the barometer below than above the mean, and greater when the range of the barometer and the number of its oscillations are above the mean. It is greater when the mean daily and dew point temperatures are above the mean, but greater when the degree of humidity is below, than when above the mean. When the wind is from the points of the compass between N.W. and S.E. by N. above the mean number of times, ozone is at its minimum, and when it is in points S. of these above the mean number, it is at its maximum. It is also at its maximum when the wind is above its mean force. When rain is above the mean quantity ozone is also at its maximum, and also with hail, but the quantity is smaller on days with snow and sleet than on days without them. With fog, thunder, and thunder and lightning, and thunder-storms, it is below the mean quantity; and it is at its maximum with negative, and minimum with positive, electricity. The mean daily quantity is greater with decreasing than with increasing readings of the barometer; and it is three times greater with wind, in points south of east, and west, than it is in points north of these. The greatest quantity (3·5) with south-west, and the smallest (0·8) in north-east points. Ozone periods commence with decreasing readings of the barometer, and increase of tempera-

ture, and with winds from south points of the compass, and terminate with increasing barometer readings, decrease of temperature, and wind from north points of the compass. These results are from 296 periods. The greatest number of ozone periods commence in S.E and a great majority terminate in N.W. points. Although the commencement of ozone periods in N.W. points is not uncommon, the S.E. may be called the points of their commencement, and the N.W. the points of their termination. The quantity of ozone is greater in the night than in the day, and with the new and full moon than with the first and last quarters, and it varies with the seasons. It is greater in January, February, and March than in April May, and June; in July, August, and September it is at its minimum, and it increases in October, November, and December. The greatest quantity is in April (2·3) and December (2·4), and the smallest in July (1·3) and August (1·3). The greatest number of ozone days is in April (2·5), and the smallest in August (1·9) and November (1·7). Although these results are from Hawarden observations only, they point to a general atmospheric law, and are supported by observations taken in other places. The quantity of ozone increases with the increase of elevation above the level of the sea; it is invariably in greater quantity in the open country than in towns and villages. It is a highly oxidised body, and it is easily decomposed by oxidable substances. If a test paper prepared with iodide of potassium be freely exposed to the air in a locality where the quantity of those substances is at a minimum, it will in time be deeply coloured brown, and ozone will be said to be at its maximum. If the test paper be placed in a locality where the quantity of oxidable substances is at a maximum, as over or in the neighbourhood of drains and cesspools, the paper will remain uncoloured, and ozone will be at its minimum. In the first condition the ozone oxidizes the potassium and sets the iodine free. In the second the ozonized air meets with incompletely oxidised substances which are more easily oxidable than the potassium. The conditions of an *ozone* period are undoubtedly those of the south, or equatorial, or ocean current of the atmosphere, and those of a *no ozone* period are as clearly those of the north, or Polar, or land current. In a medico-meteorological sense, I am not prepared to state that atmospheric ozone produces any form of disease; but I have no hesitation in saying that it prevents diseases of the epidemic character by removing their causes. The maximum of deaths takes place while the wind is in the north points. By far the greatest number of diseases, however, take place in the N.W. and S.E. points, or at the commencement of ozone periods, and these are chiefly affections of the nervous and muscular systems, from which it would appear that derangements in the nervous and muscular forces, take place at the time of transition from the no ozone and positively electric, to the ozone and negatively electric current of the air. These results are deduced from 2,727 cases of disease, and 1,149 deaths, which occurred at Hawarden, in a period of ten years. As the S. is the higher, and ozoniferous current, and the N. the lower and no ozone current of the atmosphere, in a medico-meteorological sense, there ought to be some analogy between the higher strata of the atmosphere and the S. wind, and between the lower strata and the N. wind, and observation shows that as regards ozone and deaths, they are similar. All who have paid any attention to the atmospheric condition of a cholera period, must have observed that the readings of the barometer are remarkably high, that they slowly attain their maximum, and that when they begin to decrease, they as slowly approach their minimum. While the barometer is increasing the wind continues to veer from N. to N.E. and E. until there is a perfect calm. At first the air is clear and the sky cloudless; the air becomes less clear—it thickens to haze, and the sky can no longer be perceived. There is no ozone, and the brown test papers rapidly lose their colour. There is always a calm when epidemic cholera and choleraic diarrhœa are prevalent. At the commencement of the calm there are a few cases of diarrhœa, and at last a few cases of cholera occur. The calm continues, the haze thickens and the cases of cholera *pari passu* increase in number and severity. The haze becomes a dense fog, insects fly about in swarms, and the epidemic reaches its height. The barometer having reached its maximum, begins gradually to drop, the haze becomes more of the character of a fog, and if it can be seen through, cirri will be seen hovering in the higher regions of the air or moving slowly northwards. The south current is now approaching,—the barometer continues to fall, a gentle motion of the air is perceived from the south east, ozone is detected,—there may be rain, there may be a thunder-storm,—the wind increases in force, and ozone in quantity, and cholera disappears. The rationale of this medico-meteorological process is this—The first part of the process was the north current gaining the ascendancy, and as it is the land current bearing the products of decomposition, ozone is reduced to its minimum. While the air keeps in motion, these products do not accumulate in great quantity. The barometer begins to drop; the north current falls back, and is succeeded by a calm. The products of putrefaction go on accumulating, there is no removal of air, and sulphurretted hydrogen can now be detected. Cholera cases go on increasing as the poisonous substances accumulate. As the barometer decreases slowly, the south current slowly advances; but that it is advancing is shown by the cirri, in the higher strata of the air. The air becomes more moist, because the moist current is approaching; the south or ozoniferous current at last gains the ascendancy, and cholera vanishes, because the incompletely oxidised bodies, the poisonous substances, are rendered innocuous by the ozonised air affording them oxygen. These views are supported by the facts that diarrhœa and choleraic diarrhœa are most common in the autumn months, when ozone is at its minimum, and that ozone is invariably absent during cholera periods. During the cholera epidemic at Newcastle, in 1853, the calm prevailed, and ozone was at its minimum. From the 24th August to the 11th September, 1854, ozone was only once perceived, and then in a minimum quantity, when cholera was at its height in London. On the 10th September I wrote to a friend, stating that the south or ozoniferous current was approaching, and requested him to watch its effects upon the epidemic. On the 11th we had a south wind, with ozone, and from that day the number of cases of cholera diminished. In conclusion, I have to observe that, in making ozone observations, the test paper ought to be kept in the dark; that sulphuretted hydrogen, ammonia, and moisture cause loss of colour.

The PRESIDENT, after thanking Dr. Moffat for his interesting paper, and stating that very much was not yet known about ozone, invited discussion.—Dr. ANDREWS, who spoke at some length, said that he had commenced, on different occasions, a series of experiments with the test papers, which had never yet terminated.—Dr. SMITH said that he had paid a great deal of attention to ozone. He could confirm the observations made by Dr. Andrews as to its absence in large towns. He had never found it within half a mile of the outskirts of Manchester. There had been several objections to the observations upon ozone, made by several chemists, who referred all these indications to the acid of the atmosphere. He considered that the fact that there was absolutely no indication of ozone in Manchester showed that we could not refer these indications to anything like acid; for we know that rain in Manchester is full of vitriol, and many hundred tons fall upon our heads every year in Manchester.—(Laughter.) His own observations upon ozone had led him into many difficulties; he found such contradictory results that he had not yet been able to come to any satisfactory conclusion.—Mr. J. GLAISHER, F.R.S. gave some details of experiments he had made with the test papers. He considered that the winds had not so much effect on ozone as Professor Moffat stated, because the winds from sea on to either coast brought ozone. He found it increase

with the elevation. Where there was no ozone he supposed it was destroyed by the animal exhalations in the district.—Dr. DAUBENEY exhibited a specimen of fluor spar. He had heard to his surprise that there was scarcely any indication of ozone in the highest parts of the Alps.

Dr. MOFFAT also read a paper "On sulphuretted hydrogen as a product of putrefaction." — Professor GALLOWAY read a paper "On the composition and valuation of superphosphates," which gave rise to some discussion. — Dr. SCHUNCK, F.R.S. read Professor Delff's paper "On morin, and the non-existence of moro tannic acid."—Professor ANDERSON, M.C. F.R.S. made some remarks "On the constitution of paranaphtaline, or anthacine, and some of its decomposition products," which was followed by some discussion, in which Dr. Miller and Professor Calvert took part. Professor CALVERT stated that there was every probability that in a very short time the colours from naphthaline would be introduced in Lancashire, and substituted for those of aniline.—Mr. G. C. FOSTER, B.A. F.C.S. read a paper "On piperic and hydro-piperic acids."—Four papers were postponed until Monday. — The proceedings of the section, for this day, terminated about half-past one o'clock.

SECTION C.—GEOLOGY.

Sir RODERICK I. MURCHISON presided in this section (in the lecture theatre of the Royal Institution), except during a portion of the forenoon, when he attended Section E (Geography and Ethnology), at the Mechanics' Institution.

BONE CAVES.

Mr. W. PENGELLY read a paper "On a new bone-cave at Brixham." This cavern was a second new one, discovered in March last; it is rich in fossil bones; and the district in which it exists has become famous in connection with these caverns. The hamlets forming the town of Brixham occupy a valley running nearly east and west, which is separated from Torbay on the north by a limestone hill 150 feet above the sea, while the southern boundary consists of four hills forming a chain parallel to that on the north, known as Furzeham Common, but extending a mile further eastward, where it terminates in Berry Head, the southern horn of Torbay. In Windmill Hill, the second (from the west) of the four, the celebrated cavern was discovered in 1858; and in the third is the well-known Ash Hole. After a cessation of nearly twenty years, quarrying operations had been partially resumed at Bench on the Torbay slope of Furzeham Hill; and these led to the discovery of the new cave. The quarry is being worked at right angles to the coast line. Near the top of the west or back wall, and near the angle formed by the junction of the south wall, there is a dike or breccia, made up of bones, reddish clayey earth, and angular pieces of limestone, evidently from the adjoining rock. The earth is precisely similar to that in which the bones are found embedded in the Torbay caverns. The base of the breccia is on the same level as the bone-bed in the Windmill Hill Cavern; and there can be no doubt it filled either wholly or partly, a north and south fissure. Nearly the whole of the dike was revealed during the old quarrying operations. In the exposed face, there were visible several fine bones; but even a remarkably fine left ramus of a lower jaw bristling with teeth, probably of the cave hyena, not only did not attract the attention of the workmen at the time, but it remained unobserved for 22 years. Soon after quarrying was resumed, in March last, the removal of the remnant of an outer wall, caused a portion of the dike to fall. Numerous bones were now so conspicuous amongst the earth and stones, that the principal workman soon collected several hundreds, consisting of teeth, jaws, skulls, vertebræ, and portions of horns, with a large quantity of unidentifiable bone debris. It is not likely that the dike formed originally only part of a mass filling a cavern, great part of which was destroyed by the workmen 20 years ago; for in the neighbourhood it was known that cave bones would fetch good prices. In fact, the handwriting of the departed limestone was visible on the breccia sheet that had been so long exposed. Near the southern foot of the dike is the mouth of a small tunnel, with a stalagmitic floor; its extent is not known. In the southern wall of the quarry are two larger chambers, filled with the reddish earth and limestone debris; they are known to be connected, but it is not known whether they communicate with the tunnel, but it is exceedingly probable that they are all parts of one considerable cavern. All the materials of the dike undoubtedly fell, or were washed in from above; giving a good example of what probably occurred at Orestone, near Plymouth, where observed phenomena compel the belief that the fossil bones must in this way have found ingress to the cavern, though lines of fissure are not always very distinct there. The owner had now decided himself to explore the chambers and tunnel; but although he had declined to sell the right so to do, he had always given the author access, and had promised to enable him to note every fact discovered, and he had also lent the exhibited specimens. There is a great field for exploration at Brixham. It is to be hoped that quarrymen may not in future be so blind to their own interests as to lay open a dike of osseous breccia without discovering that they have done so; and that proprietors will not, as in a case within the author's knowledge, admit that he had filled up a cavern, which he called "a large hole in the rock," by "throwing twenty cartloads of rubbish into it."

Mr. J. H. BURROW, B.A. read a paper entitled "Remarks on the bone caverns of Craven." The author said that the cave remains before the meeting were found mainly in Victoria and Doukerbottom Caves, near Settle, Yorkshire. These caverns are but two of a great number which occur in the mountain limestone, and more especially in the Lower Scar limestone of Phillips. They are of various kinds—dry, wet, from a few yards in length to a mile, merely passages, or scooped out into great chambers. Doukerbottom consists of two chambers, with very long passages between them. Victoria Cave, which was discovered by Mr. Jackson, of Settle, has in it four large chambers (which Mr. Burrow illustrated by a diagram), close to each other, and before the flooring of clay was washed in, probably forming one gigantic apartment The general section of the caves is:—First, from a foot to 18 inches of soil, in which are the bones of recent and historic animals. Second, about 6 inches of the ancient flooring of the cave, when it was inhabited by man: in this were found all the antiquities which were discovered, and the bones of animals similar to those last mentioned. Third, dense stiff clay of very great thickness, in which no antiquities and scarcely any bones were found. Fourth, the original rocky floor of the cave, resting on which were bones differing in colour, lightness, &c. from the others. The antiquities found in the second stratum were flint implements, adze-head of stone, sling stones; of bone—arrowheads, combs and pins; shells and wolf's teeth pierced for a necklace. These were evidences that an uncivilised race had occupied the cave; but besides these were fibulæ armlets and rings of bronze and iron; and coins of Roman emperors, from Nero to Constantine. The bones found were of recent and historic animals, such as the wild boar and the wolf; but with these were others o, prehistoric animals, the cave-tiger and the cave-hyena found side by side with the antiquities; and it has been argued that they are therefore contemporaneous with man. The author, however, showed that their presence in such a position was accidental, and proved too much; for if these bones were contemporary with the antiquities, they were also contemporary with the coins, which come down to 400 A.D.—a time at which we are certain, from history, that there were no such animals in England. The present evidence from these caverns of man's contemporaneousness with such animals was not to be trusted.

There was some discussion upon these papers. In the course of it Mr. Antonio Brady exhibited some flint instruments, together with bones of Ele-

phas primigenius and Echini, obtained only a few days since, from the drift at St. Acheul, near Amiens. He stated that although found only a few feet above the chalk, in the drift, in true association with the bones and shells of extinct species, still, from the composition of the drift, there was in his judgment no proof that the animals and the makers of the instruments lived at one and the same time. From the heterogeneous and rolled state of the materials, there was reason to believe that they had been disinterred by some sudden torrent or convulsion, and been re-interred in their present association. The drift had clearly never been lifted by the hand of man, but is clearly in the state in which it was deposited, whenever that may have been.

Mr. W. H. Baily communicated some "Palæontological remarks on the silurian rocks of Ireland;" and Mr. A. B. Wynne read a paper "On the geology of Knockselingowna, county Tipperary."

THE GRANITE ROCKS OF DONEGAL.

Mr. R. H. Scott read a paper "On the granite rocks of Donegal, and the minerals associated therewith." He gave a short account of a mineralogical tour made by him, in company with Professor Haughton, in the course of the summer, the results of which seemed to throw some light on the possible origin of granite. The district visited was Donegal, which county consists mainly of gneiss and mica slate, and is traversed in a N.E. direction by an axis of granite. This granite is of a peculiar composition, containing two felspars, one orthose, but the other not albite, as in the granite of the Morne mountains, but oligoclase—a mineral whose occurrence in the British Islands had only been noticed within the last twelve months. Professor Haughton, to whom this discovery is due, was unfortunately unable to attend the meeting. The facts were briefly these:—The granite contains oligoclase and quartz, which combination appears to be a proof that the rock never was in a melted condition; as in that case these two minerals would have acted on each other and formed common felspar. It lies in beds corresponding to the general lie of the strata of the country, and in its character is essentially gneissose; and, lastly, at points inside the area of the granite, metamorphic rocks (limestones and slates) are found with their bedding, which is nearly vertical, unchanged. These bands run for a distance in one case of nine miles across the country. The condition of these rocks is very similar to that of the same rocks outside the granite area; and it is a point of great interest to determine how they got there. The solution of this offered by the authors of the paper was that the whole of the rocks had been originally stratified and had been subjected to some actions which are termed metamorphic. The result of such action was to convert some into granite, some into gneiss, and some into crystalline limestone and mica schist, without very much altering their relative positions. The possibility of granite being produced by other means than simple heat seemed to them to be proved by the occurrence of felspar in quartz veins, which are usually admitted to have been filled by means of infiltration. Mr. Scott stated that there were several points in connection with these granites which showed a close relation between them and the granites of Norway. The whole question required a careful chemical and mineralogical examination, which could not be concluded for some time. Among the types of rock found in Donegal is a syenite, the felspar of which is oligoclase. The origin of this rock the authors are disposed to attribute to the addition of limestone to the granite. A similar syenite occurs at Carlingford, but contains anorthite, a felspar which would result from the admixture of a larger quantity of limestone than is necessary to produce oligoclase, and has been proved by Professor Haughton to have such an origin. The anorthile syenite never occurs unless limestone is present in large excess which is not the case in Donegal. In conclusion, Mr. Scott mentioned that the district described by him was very rich in minerals, some of which were extremely rare, and that he entertained no doubt that a more careful examination would largely increase their number.

The President said that Mr. Marshall, Mr. Scott, and other gentlemen would certainly compel the elder geologists to a great extent to modify some of their original conclusions as to granite. Much progress on the question would never be made until Professor Haughton, Mr. Scott, and others closely examined the granite rocks in Germany, Norway, and Sweden, and compared them with those in this kingdom. He much regretted that mineralogy had been dissociated from this section, and handed over to the Chemical Section; but, such being the case, Mr. Scott's communication ought to be laid before the Chemical Section. He felt so strongly the importance of the question, that he would certainly recommend the Chemical Section to consider it.—Professor Harkness said he could not accept the conclusion that granite was not an eruptive or intrusive formation. He thought that the masses had been forced into the sedimentary rocks subsequent to the great contortions or deflections which had given to these rocks their peculiar arrangement. Granite rocks always conformed in strike to the strike of the sedimentary rocks.—Mr. Scott, in reply to a remark, said he did not doubt that the same class of granitic rocks would be found in Scotland as those in Ireland.

Mr. T. A. Readwin's paper "On the gold of North Wales" was postponed to Tuesday.—The concluding papers were:—Dr. Haagen, "Comparison of fossil insects of England and Bavaria," communicated by Mr. Stainton; and Mr. Rose "On the cretaceous group in Norfolk."

Section D.—ZOOLOGY AND BOTANY.

This section resumed its sitting, at the Royal Institution, soon after eleven o'clock, when the large room was much crowded. Professor Babington presided.

MR. DARWIN ON SPECIES: HIS METHOD.

Mr. H. Fawcett made a communication "On the method of Mr. Darwin, in his treatise on the origin of species." He said that, as he could not conform to what he believed was the rule, that communications should be read (Mr. Fawcett being blind), he would promise to keep as close to his subject as though he had written his paper. The title which he originally fixed upon was, "That the method of investigation pursued by Mr. Darwin, in his treatise on the origin of species, is in strict accordance with the principles of logic." He feared that he might be charged with presumption in attempting to say anything on Mr. Darwin's great work, which had already engaged the attention of the most accomplished naturalists of the day. He had been assured that the discussion on the subject at the last meeting of the Association had never been surpassed in the interest it excited or in the talent which it called forth. Indeed, the work had divided the scientific world into two great sections—Darwinite and anti-Darwinite, were almost the badges of opposite parties. Professor Owen, Professor Sedgwick, and Mr. Hopkins had given to the new theory a decided opposition; Sir Charles Lyell, Professor Huxley, and Dr. Hooker had given to it a support more or less decided. All who took an interest in the subject had a right to inquire whether the theory—whatever might be thought of its details—had been logically brought forward. The province of logic was not to discover new facts, but to decide whether facts were legitimately used to establish that which it was pretended they proved. It was constantly alleged that Mr. Darwin was illogical; that he had not followed the Baconian method. The *Quarterly Review* assured us that Mr. Darwin had not followed in the steps of Newton and of Kepler; but nothing was more easy than to make such charges, which often only concealed pretentious assumptions of scientific knowledge. It was more pertinent to inquire — What is the method of solution of which such a problem admits? He insisted that if ever solved it could only be by a method analagous to that attempted by Mr. Darwin. It could only be solved in this way:—An hypothesis, resting upon more or less perfect induction, must be started; from that hypothesis

certain deductions must be drawn; these deductions must be tried, by seeing whether they would explain the phenomena of nature, and they must be verified by seeing whether they agreed with what can be observed in nature. If this explanation and verification was complete, the hypothesis was advanced from an unproved to the position of a proved and established theory. The Bishop of Oxford last year said that the theory was so absurd that no scientific man could for a moment think that it was in any degree worth considering. But Dr. Hooker, than whom a more eminent authority could not be quoted, at once disposed of the Bishop, by saying that as he believed the theory worth considering, he ought to "apologise for addressing the meeting as a man of no scientific authority." Dr. Hooker added that he knew of the theory five years before; that, at first, no one more opposed it; but that five years' devotion to natural history had convinced him that the theory was worthy of the most careful consideration and examination. Mr. Darwin, with the most perfect candour, explained in his work that his theory did not yet explain all the facts of nature; but it must not be supposed that his twenty years' labour had done nothing to advance the ends of science. Mr. Darwin had strictly followed the rules of the deductive method as laid down by John Stuart Mill. When Kepler inferred his law of the connection between the major axis of the planets and the times of their revolution, he so inferred from observation, which he could strictly verify by mathematical calculation. The origin of species does not admit of such a verification. In chemistry there was much more power of proof or verification by experiment than was possible in physiology; so with other sciences. When laws of nature can not be discovered by experiment, we are obliged to go to deductive reasoning. Newton had only an hypothesis, and not a theory, as to the law of gravitation; the law he first tried was an incorrect one. He tried again; and then, as Professor Whewell said, by a tentative process he discovered the correct law. Mr. Darwin had told him (the speaker) that his hypothesis was not at once suggested to him. He found in his studies that there was something wanted to explain many of the observed phenomena; years passed, and at length his hypothesis was very indirectly suggested—for he said that it came from reading Malthus's Essay on Population. Twenty years of unremitting labour he had devoted to the endeavour to verify the conclusions which might be deduced from this hypothesis by the facts observable in nature. He believed that Mr. Darwin's second work, for which the author had accumulated a great mass of knowledge, would prove beyond doubt that no one could have been a more conscientious or laborious observer than he had been. Newton could verify his hypothesis by the simplest experiment—he had but to drop a stone from a tower and to note the time occupied in its descent. But the problem of the origin of species is concerned with an epoch of time associated with geological epochs; therefore, experiment could only be made during so short a time, that nothing more could be obtained than an argument resting on a comparatively speaking unsatisfactory analogy. Darwin had been able to show that by a system of artificial natural selection two organisms, originally descending from the same form, could be made to differ so much that if they were found as fossils they would undoubtedly be classed as distinct species; and, therefore, how a morphological species could be produced. But his experiments had failed to show how a physiological species could be produced; for no one could show that two varieties from the same form could be made to differ so much that they would possess the quality of infertility. This was too often forgotten by objectors. The Egyptian sculptures were pointed to to prove that during 3,000 years the causes looked to by Darwin had done nothing to alter the form of animals. But what would be said to him who, by disovering that 3,000 years ago Mont Blanc was of the same altitude as now, should think that he had thus disposed of the theories of modern geology, that the stupendous peaks of Switzerland were lifted from their ocean bed, and that every change on the surface of the earth had been produced by an indefinite continuation of physical causes which are in ceaseless operation?—(Applause.) Mr. Darwin admitted that geology did not show that in animal life there had been those transitional links that ought to exist according to his theory, and according to any other of gradual transmutation. He (the author) could not see that this theory detracted one iota from any of the attributes of the Creator. If we supposed that the introduction of every new species required a distinctive act of creative will, then, of course, the Creator must have interposed every time a new species was introduced. But, if we supposed that every living organism has descended from those forms in which life was first placed upon this planet, it does not in the slightest degree dispense with the necessity of supposing that life could only first be so placed by the act of Omnipotent Creative Will. It was a favourite illustration in religious works, the discovery of Newton, which explains how planetary motions are produced; and he (Mr. Fawcett) believed that if ever the day came when the origin of species should be explained in fulness and simplicity, he who so explained it would be considered not only to have advanced science, but to have conferred a benefit upon religion. The attackers of Darwin forget that he has not attempted to displace a theory received as right, but merely to throw some light where all before was dark. We should, therefore, be all the more ready to welcome the conscientious labours of one who like Mr. Darwin had unremittingly devoted himself to explain to some extent what had been aptly termed the "mystery of mysteries"

Dr. Lankester thought that the discussion of Darwin's theory might be attended with great advantage to natural history. The facts brought forward in support of the hypothesis had a very different value indeed from that of the hypothesis.—(Hear, hear.) He believed that those who had supported Mr. Darwin had done so rather on the ground that his hypothesis had been a method of eliciting, arranging, and classifying a certain set of facts, than as believing that those facts led to the necessary acceptance of the hypothesis. There had never been an accepted theory of the origin of species; Mr. Darwin's strongest opponent could not pretend the contrary. But Darwin had no further evidence of the creation of one particular protoplast than any of the older naturalists had of the separate creation of a multitude of them. Persons were getting too much to mis-estimate the value of forms. They did not recollect that every departure had been produced by some physical law—by some force operating upon that particular form; and that it was necessary to study what had been the external circumstances producing that change, whether the distinct origin of species was believed in or not. A great naturalist, who was still a friend of Mr. Darwin, once said to him (Dr. Lankester): "The mistake is, that Darwin has dealt with origin. Why did he not put his facts before us, and let them rest?" He believed that that was where the public were in error—in supposing that those facts explained the origin of species.—Professor Williamson said that he would fearlessly challenge the whole of Europe to answer a question the settlement of which was a necessary preliminary to the discussion of this matter. "What is a species?"—(Hear, hear.) He believed that it would be impossible to reduce the arguments for and against Mr. Darwin to two points of departure for discussion. He knew nothing further from being entitled to rank as a theory than the conclusions to which Mr. Darwin had arrived; and while he would not say that Mr. Darwin's book had caused him a loss of reputation, he was sure that it had not caused a gain.—Mr. Lubbock thought that there had been an advance upon the question; for, while last year the discussion was objected to on a fundamental point, now credit was given to Mr. Darwin for work done, and only his conclusions were objected to.—The Right Hon. Joseph R. Napier said that his objection was, that Mr. Darwin put forward facts to contradict what

we knew of the origin of life. When he (Mr. Napier) was told by the Word of God that God breathed into man's nostrils the breath of life; and when he found that our Lord referred back to the Creation ——. A MEMBER objected that the right honourable gentleman was going into a theological discussion, which was misplaced.—Mr. NAPIER: I was going to speak closely to the question. If the hypothesis is put forth to contradict facts, and the averments are contrary to the Word of God, I say that it is not a logical argument.—The CHAIRMAN said he was sorry to interfere; but they were met for scientific, not theological discussion.—Mr. NAPIER contended that Darwin had got no further than mere suppositions, proving nothing; therefore what was called his method was not logical. He certainly supposed that, in a country like ours, a man was at liberty to say that to bring forward an hypothesis contradicting the plain averments of Divine truth could not be a logical argument. Darwin confounded modification with advancement. You might go on modifying, without showing advancement. He thought that no more sound objection to the so-called theory could be urged than that it embraced nothing but the suppositions of a human being, in contradiction to the plain word of God.—Professor WILLIAMSON hoped that it would not be supposed that any irreligious tendency was implied by the objection taken to the line of argument of the last speaker. No one more fully felt the propriety of such arguments in their proper place than he himself.—Mr. J. G. JEFFREYS said that geologists were well aware that in the upper tertiaries, the period of which extended over thousands, nay millions, of years, the remains of animals were found agreeing in the most critical particulars with those of others still existing in our own seas. The great value of Mr. Darwin's hypothesis was to excite naturalists to continue their researches, so that they might hereafter arrive at more definite conclusions than were now possible.—Mr. FAWCETT said that after the discussion, he thought Mr. Darwin might be consoled by the conviction that the British Association considered that he was pursuing a perfectly philosophical and logically correct method, and was doing everything a man could do to establish a theory on the subject of the origin of species.

Dr. COLLINGWOOD submitted "A scheme to induce the mercantile marine to aid in the advancement of science by the collection of objects of natural history."

THE FLORA OF MANCHESTER.

Mr. L. H. GRINDON read a paper "On the flora of Manchester." The number of species of flowering plants indigenous to Great Britain is about 1,500. The flora of any given district of 18 miles radius usually includes about one-half of these, the species varying with the geological conditions, the proximity of the sea, and the local climate; and the ordinary vegetation being composed of about one fourth, or, in round numbers, of 370 or 380 species. The flora of Manchester is rather below the average, chiefly because of the level surface of the country and the unfavourable character of the soil, partly by reason of the ungenial climate. Unproductive clay and sandstone are almost universal; extensive peat-mosses cover up large portions of the original surface: and although upon the north and east the ground is elevated, this adds little to the variety of the flora, since these higher parts are entirely moorland, desolate, and storm beaten. Limestone, chalk, lias, tidal rivers, marshes impregnated by the sea are, near Manchester, altogether unknown. Plants peculiar to such habitats are of course entirely wanting. The fragrant Labiates, the yellow flowered Umbelliferæ, Malvas, Cotyledon, mural ferns, Clematis, rarely or never make their appearance here. Plants in the limestone and sub-maritime districts so common even as wild thyme, Papaver Rhœas, Cistus, Clinopodium, Cynoglossum, Plantago media, scarcely enter, if at all, into the area we deem our property. Insectiform orchids are absolutely unknown. So too are all grasses that need calcareous earth, or the scent of the ocean, such as Hordeum pratense, Hordeum murinum, Hordeum maritimum. The absence of these is remarked immediately by every one who comes from within a limestone district; the want of their familiar forms makes the flora seem poor and dull; and it must be confessed that the species which our local conditions give us in substitute, are far below them in interest and beauty. Not that we are destitute of striking and brilliant flowers; the foxglove is plentiful, and attains considerable stature; Campanula latifolia and the white water lily reckon among our common plants; and there is, probably, no district in England where the first steps of spring are marked by so great an abundance of the wood-anemone, the wood-hyacinth, and the crimson lychnis. The local climate is no less unfavourable than the soil to a rich and remarkable flora. During a considerable portion of the year the amosphere is cold and humid. The approach of spring is generally checked for several weeks after commencement by destructive east winds; the summer is often distinguished chiefly by the longer days; and autum and winter return speedily and sharply. The consequence is that numbers of plants which would probably accommodate themselves to the soil, were the atmospheric circumstances congenial, fail to bloom early enough to ripen their seeds; or if the seeds be ripened now and then, the progeny is weak and scanty. The influence of these adverse circumstances is particularly manifested in the ill-development of our trees. There are no elms deserving the name; the oak and the ash are very feebly represented. The beech does pretty well in our Cheshire parks, but the only tree that can be said to flourish here is the sycamore. The most abundant tree is the unsightly black poplar. The positive character of the Manchester flora consists accordingly in the presence of 370 or 380 British plants, which are indifferent to the soil they grow upon, and which clay and sandstone suit as well as any other. These are, of course, the common plants of the country in general; and were it not that the peat-bogs furnish many species peculiar to such habitats, and that the low level of the country and the abundance of moisture combine to the production of innumerable marshy hollows, in which plants are found plentifully that the limestone districts afford penuriously or not at all—were it not for these, the Manchester flora would be no more than a list of cosmopolites. The ponds of the district, locally called "pits," are innumerable. In Cheshire they often become enlarged into beautiful sheets of water, called "meres," which greatly enhance the picturesque character of the northern parts of this county. South-east Lancashire contributes also a peculiar class of habitats in its innumerable and very pretty little winding ravines, locally called "cloughs," the sides clothed with trees, and a stream running along the bottom. These, like the marshy hollows, supply many plants in great abundance that districts more favoured in soil and climate fail to offer, and, along with the peat-mosses, supply the principal part of what is locally interesting. Of rare and extraordinary plants we do not possess a single instance, except when they appear, as in other places, adventitiously. We have no permanent treasures or rarities, such as give celebrity to St. Vincent's Rocks, the Great Ormshead, and the Scotch mountains. If a claim to such a character can be asserted by any of our plants, that claim must come from *Carex elongata*. Let me now specify, in a few words, the plants of chief interest that occur in a flora not distinguished for anything remarkable or uncommon, except when contrasted with special districts. Beginning with the meadows and pastures, the least common plants elsewhere are Myrrhis adorata, Sanguisorba officinalis, Alchemilla vulgaris, and Polygonum Bistorta, all of which grow near Manchester in profusion. The leaves of the Bistorta are collected by the rustics, and eaten, when boiled, under the name of "sweet-dock." The others are collected in great quantities, along with everything else of real or supposed medicinal or culinary value, and either brought to market or applied to their reputed use at home. There is probably no district in our country where so great faith is placed in the economic and curative virtues of the wild plants, or where the most unlikely species are

collected with equal avidity, astringent and bitter plants, such as Agrimonia and Erythræa, (the latter commonly called "Sanctuary"), having been almost exterminated. The berbery and Daphne Laureola have shared a similar fate. Even the common nettle, in certain districts near Heywood, has become a rare plant, through the fondness of the people for the young tops, boiled as "greens," and for a beverage called "Nettle-beer." Menyanthes trifoliata is also largely collected for medicinal use, but there is no fear of this being exterminated, every low wet meadow in some districts producing abundance. Among the corn, and in ploughed land generally, we are accustomed to see the lively yellow and purple of the Galeopsis versicolor, a plant which there can be little doubt is only a patrician form of the tetrahit. On the peat bogs, which occupy large breadths of land upon almost every side of Manchester, we have many curious plants, though none but what are abundant in similar habitats elsewhere. The mass of the vegetation consists of Eriophorum, Drosera, Narthecium, Erica Tetralix, Calluna vulgaris, Vaccinium oxycocos, Andromeda polifolia, all of which flourish in these wild and otherwise dreary plains, in the highest beauty of their respective kinds. Mingled with them are Molinia cœrulea, Sphagnums, and lichens. In some cases Eriophorum polystachyon prevails; in others the Eriophorum vaginatum; and the same is to be said of the two predominant Droseras, Anglica and rotundifolia. One of the greatest enjoyments the Manchester botanist has at command, is found in a visit to one of these great moors shortly after midsummer, when the silver tassels of the Eriophora whiten them with summer snow, or they are illuminated with the deep gold of the Lancashire asphodel. Many persons collect plants of drosera to keep as a parlour ornament, since they live well plunged in a little bog moss, and kept in a saucer of water. Droseras are favourite plants also in some of our ferneries and orchid houses. Not only are the bogs themselves productive of botanical interest; on their borders, especially in the ditches cut for draining, there is usually abundance of luxuriant Blechnum boreale, and frequently, also, plenty of Osmunda regalis. It is in these localities that the Manchester botanist finds compensation for the flatness of his neighbourhood, and the absence of limestone. The plants they afford him are strangers to calcareous districts, and give as much pleasure to the visitor from Gloucestershire or Wiltshire as the Manchester botanist receives from those of the chalk and the saltmarsh. The Andromeda blooms twice, in May and again in August, so that it is not unusual to find the second bloom accompanied by ripening fruit, as happens with the orange tree, the snowberry, and the Rhamus frangula. Up to a very recent period there were many partially dry moors near Manchester, but these are now nearly all brought under cultivation. While untouched by the plough, they were enlivened every autumn by the beautiful blue of the Gentiana pneumonanthe, which is now found in plenty nowhere nearer than at Newton-le-Willows. The Osmunda seems less likely to be effaced, being distributed over the whole north-east of Cheshire. The marshy grounds of the district, including the borders of the Cheshire meres and the countless ponds are rich in cyperacaæ. The British species of this family amount to about 100, three fourths being carices, and nearly the whole are represented here. Cladium Mariscus, and some of the carices, as strigosa and axillaris, are confined to one or two localities, but the others are abundant. Carex pseudo-cyperus and ampullacea belong to the common vegetation. The borders of the ponds and their shallow portions are full of comarum palustre. Many of them are bordered by the Acorus calamus, or enriched with the noble cups of the Ranunculus lingua. The water of others is half hidden by the aloe-like Stratiotes, or by great floating islands of Polygonum amphibium. Utricularia occurs sparingly, and Myriophyllum and Potamogetons are universal. The borders of Capesthorne Mere are further esteemed for the abundance of Aspidium Thelypteris which may be gathered there. Several other charming aquatic and amphibious and waterside plants may occasionally be seen in our streams and ponds; but there is good reason to believe that they have been introduced. It is well known that the operative botanists of this district, famous as a class for more than a century, have taken great pleasure in planting the roots of beautiful species that they have brought home with them after a botanical journey, and that the actual indigenous flora has thus, in many instances been enhanced in beauty, though the appearance presented to the unwary is deceptive. Wherever water stagnates, or is apt to overflow, as well as upon every river bank, there is an enormous quantity of Petasites. This curious plant is one of the most noticeable of the Manchester flora. In spring we recognise its lilac thyrsi upon every little peninsula formed by the windings of shallow watercourses, and in autumn the half-dried mud is concealed by its prodigious foliage. For a day or two in June, while the atmosphere is warm and still, and its pagodas of white winged seeds stand erect and undismantled; it presents one of the most remarkable spectacles in English botany. The plants of the moorlands, where the sportsmen go for grouse, are not very numerous, but in many instances, of singular curiosity. Here are found, comprising the general vegetation, all those aborigines of our island that love great solitudes, the heather, the whortleberry, Nardus stricta, Juncus squarrosus, Empetrum nigrum, and in many spots abundance of Vaccinium Vitis Idæa. Lycopodium clavatum, alpinum, and Selago, Arctostaphylos uva-ursi, and the parsley fern occur in a few places, and on the moors above Greenfield there is plenty of the beautiful cloudberry, the berries of which are collected and brought as gifts to friends in town, but never appear in the markets. None of these latter can be included in the list of ordinary plants, the particular localities being few and wide apart. Here and there, while searching for them, the enthusiast in botany finds Listera cordata, Meum Athamanticum, and Campanula hederacea. The whortleberry is so abundant that in August the town fruit dealers are never without basketsful of its juicy produce. This plant is by no means confined to the moorlands; at the distance of some few miles it often appears upon the level of the streets of Manchester. The predominant ferns of the moors are, in the rougher and more exposed parts, Blechnum boreale, and on the sheltered and sunward slopes Aspidium Oreopteris. The cloughs are, next to the peat bogs, in favour with the Manchester botanist. Those of Cheshire, are saturated in early summer with the deep blue of the Myosotis sylvatica; and those of Lancashire, are crowded at the same period with that charming miniature of the larch tree, the Equisetum sylvaticum. The profusion of this plant at a distance of no more even than three or four miles from the town, is truly astonishing. Every bank and hollow is adorned with its elegant green cupolas, and it not uncommonly wanders into the open fields. In moist yarts of these cloughs there is often abundance of Viola palustris. Asperula odorata is rarely below its maximum, both of beauty and luxuriance; and the underwood usually consists, in great measure, of the wild raspberry. Polypodium Phegopteris and Dryopteris occur plentifully, and generally in near neighbourhood. Scolopendrium is found in a few, but the principal fern is Aspidium dilatatum. The Cheshire cloughs, charming Vallambrosas in every case, offer Paris quadrifolia, Vicia sylvatica, Carex strigosa, Milium effusum, Daphne Laureola, Epipactis latifolio. Those of Lancashire, which are often in a high degree wild and romantic, with abundance of legend and tradition clinging to them, occasionally reward the explorer of their wild seclusion with Rubus saxatilis and Impatiens Noli-me-tangere. The ferns in all these cloughs attain a surprising beauty and richness. All the large plume-like ferns are found in them, Filix-mas, Filix-fœmina, and Oreopteris predominating, and there are few wherein the oak-fern and the beech-fern may not be found. The Cryptogamia of the district have in some departments been diligently examined. Of mosses we have 220 out of the 440 British species, being exactly one-half, and including the Orthodontium gracile. Jungermannias and their allies are

equally well represented. The British species being 93, and the Manchester share of them about 40. The abundance of these two families is chiefly referable to the congenial habitats they find in our damp and shady cloughs, especially those of Cheshire. The circumstances which favour their appearance are adverse to a multitude of lichens, for, even taking in all the species of the high grounds and the moorlands, we have only about 80 out of the 400 reputed native. At least, these are all that have so far been observed. Fungi prevail in the same ratio as in most places where the atmosphere is humid. Fresh water algæ are also tolerably plentiful; 40 well-marked species can be easily procured in the course of a summer, and while hunting for them it is easy to procure desmids and diatoms. No less than 60 of the former and 30 of the Diatomaceæ were made out in the course of a few weeks, about fifteen years ago, when the study of them was first undertaken in Manchester. On a review of the whole subject it appears, then, that the Manchester district, although exposed to great disadvantages, is, on the whole, quite as productive of interesting plants as any other. They are fewer in number, and they are less brilliant in appearance; nevertheless, the botanist who would wish to enjoy himself, and to find everything necessary to intimate acquaintance with the types of the British flora, need not distress himself at the seeming dearth of Manchester. If he will seek he will find, his reward augmenting in the ratio of his philosophy.

Sub-section D.—PHYSIOLOGY.

The Sub-section met again in the Gallery of Antique Sculpture at the Royal Institution; Dr. John Davy presiding.

Mr. Charles Robinson read a paper "On the occipital vertebræ in osseous fishes."

Dr. Lionel Beale read a communication "On the structure and growth of the elementary parts (cells) of living beings." The object of the author was to prove, amongst other points—That all tissues consist of elementary parts, and that each elementary part (cell) is composed of matter in two states — germinal matter and formed material. The only part of the matter of which living structures are composed, which possesses the power of selecting pabulum, and of transforming this into various substances—of growing, multiplying, and forming tissue—are those which he terms germinal matter. The powers of growth of this matter are infinite; but for the manifestation of the powers, even in a limited degree, certain conditions must be present. Growth always occurs under certain restrictions. Germinal matter is composed of spherical particles, and each of those of smaller spherules. New centres of growth originate in the spherical masses. Nuclei therefore are not formed first, and other structures built up around them; but nuclei are new centres, originating in pre-existent centres. All tissue (cell wall, intercellular substance, &c.) was once in the state of germinal matter and resulted from changes occurring in the oldest particles of the masses of germinal matter. What the author calls "intercellular substance" corresponds with the cell wall of a single cell; and there is no more reason for believing that this structure results from any inherent power to form matrix, or that the intercellular substance is simply deposited from the nutrient fluid, than for believing that the capsule of mildew can grow independently of the matter it encloses, or be formed by being precipitated from the medium which surrounds it. There is a period in the existence of cartilage and allied structures, in which there is no true "intercellular substance." In nutrition, the inanimate matter permeates the formed material, and passes into the germinal matter, where it undergoes conversion into this substance. The old particles of germinal matter become converted into formed material. Growth, therefore, always takes place from centre to circumference. The relative proportion of germinal matter and formed material varies greatly in different elementary parts, in the same elementary part at different periods of its growth, and in the same tissue under different circumstances. The more rapidly growth proceeds, the larger the amount of germinal matter produced in proportion to the formed material. In all living beings, the matter upon which existence depends is the germinal matter; and in all living structures the germinal matter possesses the same general characters, although its powers and the results of its life are so very different.

IS HAIR SUBJECT TO SUDDEN CHANGE IN COLOUR?

The President read a paper on this subject. The popular notion is decidedly in favour of the affirmative, and many naturalists and physiologists have come to the same conclusion. They adduce instances of the change of the hair to white or grey, in the case of persons under strong emotions of grief or terror. Haller, in his "Elementa Physiologiæ," refers to eight authorities for examples of such changes; but all that he seems to admit for himself is that under the influence of impaired health such a change may take place slowly. Marie Antoinette was cited by favourers of the popular notion as a striking and well authenticated instance; but when fairly considered, the case came under the condition admitted by Haller. Had it been possible for mental emotion, whether of terror or of grief, to render hair suddenly grey, surely in the Queen's case the change should have been witnessed at an earlier period than that of the arrest of the Royal Family in their attempt to leave France. If such a sudden change could be presumed, might we not expect to witness it in soldiers engaged in an active campaign amidst all the dangers and horrors of war. He had himself examined thousands of soldiers, men prematurely worn out in various climates, and concerned in many a hard-fought battle—many of them grievously wounded—but he never met with an instance of the kind. The case of a rebel Sepoy is stated by Dr. Laycock, in the April number of the *British and Foreign Medico-Chirurgical Review*, on the authority of Surgeon Parry; it being said that the man's hair changed from black to grey in half an hour. He was undoubtedly under the belief that he would be condemned to death. Might not this be the explanation: the man was hurried in, profusely perspiring; he was naked, and cooling and drying rapidly, his hair, previously grey, being darkened by moisture, resumed its natural colour. The effect of water in intensifying colour is well known; and a further circumstance in aid of the explanation given may be found in the fact that the natives of Bengal are in the habit of staining their hair. The transactions of the Royal Society, extending over 200 years, do not contain an instance of such change in the colour of the hair—a circumstance opposed to the conclusion that it ever took place, for had it ever been undoubtedly witnessed, it is not likely that it would have remained undescribed. The author is not aware that, irrespective of recorded evidence, anything in support of the popular notion can be adduced on physiological grounds. Human hair cannot be injected. Using colouring fluids, such as a solution of nitrate of silver and a solution of iodine, the author has not observed any change of colour, except in the portions actually immersed. Whether it owes its colour to a fixed oil, to a peculiar arrangement of its constitutional molecules, or to both, it resists decay in a remarkable manner; it resists the action of acids and alkalies, except the strongest, which dissolve it. It resists maceration, and even boiling water, except continued for a long time, and under pressure, when it suffers disintegration and decomposition. Exposure to the sun will bleach hair, but this will not account for any very sudden change of colour. Supporters of the popular opinion refer to changes in the plumage of birds, such as the ptarmigan, and in the hair of certain quadrupeds, such as the mountain hare and ermine, which become white towards winter, and of a darker hue when the winter is passed. The belief is rested on that this is not caused by moulting, or a change of coats, but that it takes place in the existing feathers and hair. But there is no satisfactory evidence of such changes; and considering the qualities of both, they seem most improbable. There is good proof that

in the ptarmigan the change is decidedly connected with moulting; at least such is the author's decided impression from inspecting the numerous specimens, shot at different seasons, belonging to Mr. Gould—which eminent ornithologist says that the "ptarmigan is always moulting," the changes being from brown in the summer, to speckled in the autumn, and white in the winter. The speckled feathers, few and large, overlap the white; and as soon as those few are shed, the bird appears in its white dress. The similar change amongst quadrupeds, most probably arises from the same cause; and examples, less striking than those amongst wild animals, can be observed in cases of the horse and the cow. Professor Rolleston, of Oxford, had given to the author a portion of the hair of a pony which has been observed to change its coat from tawny to nearly white in winter. Mr. Erasmus Wilson, who advocates the popular doctrine, refers to the case of a lemming in support of his views; but Mr. Blyth, a naturalist, says that he examined a lemming killed during its autumnal change, and satisfied himself that "the white hairs were all new, and not the brown changed in colour." There are reasons why it might be expected that the summer coat and plumage should be darker than those of the winter. The author concludes that whether we consider one side of the question or the other—the human evidence so questionable, the physiological so much more reliable—the idea of fallacy is unavoidable, as to the hair being subject to sudden change of colour from mental impression. The attempts made to explain such a change by physiologists are allowed to be complete failures; and more amusing attempts had been made to explain the phenomenon on other grounds than those of fallacy. The author, when on foreign service, knew an assistant surgeon of a regiment who had become insane, and whom he visited a fortnight or three weeks subsequently. The patient's hair, before brown, had become grey; but when he called attention to the fact, the regimental surgeon simply said, "Your surprise will cease, when you know that —— has, since he has been afflicted with his malady, discontinued dyeing his hair." When we consider how prone the hair of some persons is to turn grey at an early age, even without accompanying or preceding bodily ailment, and how many would wish to conceal this blemish, and so have recourse to chemical means, it is easy to imagine that this source of error may not be unfrequent. Nor should it be overlooked that there is a disposition in some to make statements merely for the sake of exciting momentary surprise or of acquiring ephemeral notoriety. If we consult the records of imposition and delusion, we shall find many a thing attested, and for a time believed, of as marvellous a kind as the sudden whitening of the human hair. Has not witchcraft had its defenders? Have not table-turning, clairvoyance, and spirit rapping had believers? Have there not been even physiologists who have given their credence to spontaneous combustion of the human body and to equivocal generation?

Professor ROLLESTON referred to the case of the pony mentioned by the President; and generally approved of that gentleman's conclusions.—Mr. JOHN WINDSOR said that in 1849 he was told by a lady in Paris, that in 1848, during the revolution, her own hair changed from dark to white during one night; but he should be inclined to rely upon the President's conclusions.—Mr. H. STRICKLAND said he was convinced that in the natural history part of the subject Dr. Davy was altogther wrong. As to birds, he was positive, from his own observations, that changes of colour, from white to dark, resulted from a process of marbling; and that such changes were universally effected quite apart from moulting, and often in a few days.—Professor WILLIAMSON fully agreed with Mr. Strickland as to birds; it was still a question whether Mr. Strickland's facts proved that the human hair could change suddenly in colour.—Sir JOHN RICHARDSON believed that change of colour in some animals arose simply from the breaking off of the ends of the hair. As to birds, he knew that moulting was very rapid indeed in certain climates and seasons; and that the pen feathers often extended so as to hide the change of colour until they dropped off. Before the question raised could be at all settled, there must be more patient and laborious examination than any of which he (Sir John Richardson) had yet seen a record.—Dr. WILLIAMS said he had never met with a single case of a sudden change in human hair; but he knew several in which there had been an almost total loss of colour, in the course of a few weeks. He believed that the stories of sudden changes were appeals to credulity rather than facts.

RESEARCHES ON RESUSCITATION.

Dr. B. W. RICHARDSON communicated some "Physiological researches on resuscitation." The idea of the possibility of restoring life after some forms of death was noticed by the Greeks, by Roger Bacon, by Harvey, by Stahl, and by Hunter. That which was but an idea had now become by the course of physiological research, almost a reality. He should define death as a condition in which respiration and the heart-beat had ceased. The only forms of death in which means of resuscitation could be used are those in which it had occurred without injury to the structures of the body—such as drowning, the inhalation of chloroform, sudden death, and suffocation by carbonic acid. The methods employed for resuscitation are artificial respiration, galvanism, injection of fluids into the bloodvessels, and a method of his own, which he called artificial circulation. He gave the results of sixty cases, in which simple air was used; and of experiments in which oxygen, peroxide of hydrogen, chlorine, heated air, or ozone were employed. The great point brought out was that the inhalation of air at 130 degrees materially favoured the restoration of life when the heart had not stopped: and the author suggests that in all receiving-houses for persons apparently dead, a heated-air bath shall be kept ready. When the heart has quite ceased, no artificial respiration can be of any avail. Galvanism was first used by Aldini. It could be employed for one or two purposes, such as starting respiration or the heart; but up to the present time, as employed, it has been an entire failure, and as it excites muscle, it is worse than useless and should not be applied. The idea of injecting the bloodvessels was first thrown out during the 16th century; and it has been shown by recent inquiry that the injection of blood into animals even when stiffened by death, will re-produce muscular action. The author discovered that warm water will produce the same effect. The difficulties consist, as regards blood, in obtaining it; and in the case of water, in the fact that it decomposes blood after a time. The author has tried various other agents of injection, such as oxygen and the peroxide of hydrogen; but these failed from physical reasons. The author's last plan was a method of starting mechanically the blood in the dead body, or of artificial circulation. There are three methods by which this can be attempted; but they have as yet been operations of too formidable a nature to be used practically. The author's conclusions are—In cases of suspended animation, if a patient breathes at all—place him in warm air and give plenty of it; but do not meddle further. If respiration has ceased, set it up by means of bellows and warm air; continue this for 15 minutes if necessary, for the heart may not have ceased to act, and, if not, the operation often succeeds. The common practice of using galvanism or electricity in an empirical way is unadvisable and often dangerous. The great desideratum is an improved method of producing an artificial circulation of blood, and so supplementing the heart.

In the course of the discussion which followed, Dr. SIMPSON, of Edinburgh, said he quite agreed that in many cases, galvanism was a most injurious and dangerous agency. In cases of poisoning, chloroform was often an excellent agent. Give strychnine to two dogs. Leave one alone, and it would die in a few hours. Treat the other with chloroform for several hours, sometimes for from twelve to twenty, and the animal would survive. This had been done successfully in one or two cases of

poisoning in the human subject.—Dr. RICHARDSON said that as to galvanism there was great danger of easily carrying the application too far; and no one could give to another any previous general instructions which would enable him to know when the application ought to be stopped. He was delighted to find that his observations had met with the general concurrence of Dr. Simpson.

The reading of two or three papers was postponed.

SECTION E.—GEOGRAPHY & ETHNOLOGY.

The proceedings were conducted as on the previous days, at the Lecture Hall of the Mechanics' Institution, David-street, the president of the section, John Craufurd, Esq. in the chair. Professor Owen was announced to read the first paper, but as Sir Roderick Murchison desired to proceed to the meeting of the Geological Section, it was decided that several communications which he had prepared should be proceeded with. One of these, "A letter from the Colonial Office, on the exploration of North-western Australia, under Mr. Gregory," had been mislaid, but Sir R. MURCHISON remarked that a sum of money exceeding that which was originally contemplated, was required to enable Mr. Gregory to complete his exploration of North-western Australia. The object of the expedition was to turn the north-western corner, as it were, of Australia, to proceed as far eastward as possible, towards the Cambridge Gulf. The colonists had a more limited object—the extension of their feeding grounds beyond the Gascoigne river, and a certain river called after him (Sir R. Murchison) many years ago by Sir G. Grey. It was to proceed by sea to a very considerable distance beyond the limits of former explorations, then to disembark, and ascertain the real nature of the coast line, &c. and to penetrate so far inwards as to ascertain whether there be great tracts of cultivatable land there. Mr. Gregory had penetrated a considerable distance into the interior, and was stopped by a saline desert, perfectly dry. It was proposed to go right across to the Gulf of Carpentaria, afterwards down to Queensland, then to New South Wales, and so complete the exploration. In consequence of the researches already made, colonists have gone very far into the interior for the pasture of their flocks. The subject was of the utmost natural and international importance. That remarkable man, Mr. Stewart, had recently penetrated through Southern Australia, as far in fact as the watershed of Northern Australia—a fact never accomplished before, and which he (Sir R. Murchison), thought was 500 miles beyond the extreme point which had been previously reached by Captain Sturt. It might be anticipated that it would soon be practicable to make a telegraph across the whole of Australia, and so communicate with our Indian possessions; and that settlements of English people might be formed there, in a climate where cotton was a native plant. The great importance of the subject had led him to bring the merits of that distinguished man (Mr. Frank Gregory) before the notice of that section.

The next subject was "An appeal on behalf of the only son of the great traveller, the late Thomas Atkinson, Esq. F.R.G.S." which was also made by Sir R. I. MURCHISON. He said that Eastern Siberia, and the great steppes beyond it, were explored a few years ago by that remarkable and enterprising traveller, Thomas Atkinson, who once lived in Manchester, and had built one very good church here, and whose skill and taste as a landscape painter were well known—who had directed his enterprise for a series of years to the exploration of those remarkable regions of Mongolia and the eastern steppes of the Kirghis. The volumes which he had published had been received with much approbation by the public, and had been read with much avidity; and he had thrown much light upon tracks in which he might venture to assert not only no Englishman, but scarcely any European, had previously trod. He knew of no traveller that had penetrated where this remarkable man had been. In his travels he had a spirited wife, who accompanied him throughout—and, at the foot of one of those desolate mountains—the Alatau (in the Actau range, in the middle horde of the Kirghis, and near the celebrated spring Tamschiboulac), she gave birth to their only son, now twelve years old, who, by the lamented death of Mr. Atkinson, at Walmer, only a few weeks ago, was left in a state of want. For Mr. Atkinson did not travel at the expense of either the Russian or the British government, but entirely at his own cost, and had expended his little means in his extraordinary journeys. It therefore occurred to him (Sir R. Murchison), as it had on similar occasions, that it was his duty, as the President of the Geological Society, to make some appeal to the public in order to establish a fund to help in the education of that fine boy, who in commemoration of his having been born in such a remarkable spot, had been named Alatau Tamschiboulac Atkinson. They were of course exceedingly anxious that this young man, with so remarkable a geographical name, should in future life prove equal to his father; and in order to enable him to do so, the first thing was to give him a good education. Therefore, was made this little appeal. Subscriptions would be received in London, at the rooms of the Royal Geographical Society, 15, Whitehall Place, and by the bankers of the Society, Messrs. Cocks and Biddulph, Charing Cross; and in Manchester by Dr. Shaw, the secretary of the Geographical and Ethnological Society as well as by the local treasurers of the British Association.—The following subscriptions were then announced:—Sir R. I. Murchison, V.P.R.G.S. £20; William Fairbairn, Esq. F.R.S. £10; John Craufurd, Esq. F.R.S. £5; Charles White, Esq. F.G.S. £10; William Spottiswoode, Esq. F.R.S. £5; and H. Danby Seymour, Esq. M.P. £5.—"A letter from Sir Hercules Robinson, governor of Hong Kong, relating to the progress of Major Sard, Captain Blackiston, and others who are endeavouring to pass from China to the north of India," which was to have been communicated by Sir R. I. Murchison, was deferred until Monday.

Professor OWEN, F.R.S. &c. then read his paper "On the osteology and dentition of the natives of the Andaman Islands." Having noticed the geography of the Andaman Islands, Professor Owen quoted evidence to show that the diminutive black aborigines of these islands had no notions of a deity, of spiritual beings, or a future state; that both sexes went naked, without any sense of shame. He then gave an extract from the writings of Dr. Mouatt in corroboration of the destitution of civilisation prevalent amongst the Andamanners. Their chief weapons were bows and arrows, some of the males also carrying a kind of spear. They appeared to be devoid of fear, were powerful for their size, were swift runners and excellent swimmers and divers. Three or four of them had been known (according to an account given by a Sepoy) to dive into deep water and bring up a fish six or seven feet in length, which they had seized. They were also gifted with extraordinary powers of vision. By their acute sense of smell they often detected afar off the existence of fruit in the neighbouring lofty trees. They spun ropes, made wicker baskets, nets for catching turtle and fishes, and scooped out canoes with a small kind of adze. Thus for all their immediate wants invention had supplied the instruments called for by the nature of the surrounding objects and sources of food. But their life was still little beyond that of the brute animal; and their low grade of humanity, with the dwarfish stature and black colour of the Andamanners, had always made a further knowledge of their physical characters peculiarly desirable. He (Professor Owen) was enabled to contribute the present notice of their osteological and dental characters by the opportunity kindly afforded him by Dr. Frederick J. Mouatt, inspector of Indian gaols, who had brought over the bones of an adult male native of the Andamans and had now presented them to the British Museum. The bones presented a compact sound texture, with the processes, &c. well defined. The cranium was well formed. The teeth equalled in size those of Indo-Europeans. After minutely describing the whole of the bones, Professor Owen re-

marked that the dimensions of parts of the skeleton indicated that they were from an individual 4ft. 10in. in height. The Andamans or Mincopie were called by most of the observers who had described them "negrillos" or dwarf negroes. They had no knowledge, and appeared to have no idea, of their own origin. It had been surmised that they might be the descendents of African negroes imported by the Portuguese for slave labour in their settle ments at Pegu, and who had been wrecked on the Andamans. But the recorders of this hypothesis alluded to it as a mere hearsay. Neither the skull nor the teeth of the male Andaman above described offered any of the characters held to be distinctive of the African negroes. The cranium had not the relative narrowness ascribed to that of the negro. It presented nothing suggestive of lateral compression. It conformed to the full oval type, with a slight degree of prognatheism; and was altogether on a smaller scale than in the Indo-Europeans exhibiting that form of skull. It is to be presumed that the Portuguese would import from the Guinea Coast or other mart of negro slaves, individuals of the usual stature; and it was incredible that their descendants, enjoying freedom in a tropical locality affording such a sufficiency and even abundance of food as the Andamans were testified to supply, should have degenerated in stature in the course of two or three centuries to the characteristic dwarfishness of the otherwise well-made, well-nourished, strong, and active natives of the Andaman islands. He concluded, therefore, that they were aborigines, and merely resembled negroes in the blackness of the tegumentary pigment, which might be due to constant exposure in such a nude and primitive race. The observation of the hair of the scalp, though perhaps unsatisfactory with respect to a race which habitually shaved or eradicated the hair, were it exact in regard to the crisp, curly, or woolly character of the hair, would show a resemblance of the Andamanners to the Papuans and Australians, as well as to the African negroes. But the skull and dentition of the Andaman male was still more distinct from the Papuan-Australian type than from that of the west coast negro. From the present opportunity of studying the osteology and dentition of the Andamanner, the ethnologist derived as little indication or ground of surmise of the origin of the race in question from an Australasian as from an African continent; and there was scarcely better evidence of his Malayan or Mongolian ancestors. He was not cognisant of any anatomical grounds for deriving the Andaman people from any existing continent. He intended to give no encouragement, however, to a belief that they originated in the locality to which they were now limited. Dr. Latham stated that their language showed them to belong to the same division with the Burmese of the opposite continent. These, however, showed the average stature of the Southern Asiatic men; and it would be as pure an assumption to affirm that they had been derived from the Andamanners as that these were degenerate descendants of the Burmese. The cardinal defect of speculators on the origin of the human species was the assumption that the present geographical condition of the earth's surface was anterior to, or at least co-existent with, the origin of such species. The Andamanners were, perhaps, the most primitive and lowest in the scale of civilisation of the human race. The animal appetites were gratified in the simplest animal fashion. They were not cannibals. Implacably hostile to strangers, they had made no advance in the few centuries during which their seas had been traversed by ships of higher races. Enjoying the merest animal life for centuries, why might they not have so existed for thousands of years? Antecedent generations of the race might have co-existed with the slow and gradual geological changes which had obliterated the place or continent of their primitive origin, whatever were the hypothesis adopted regarding it. The Andamanners approached the orangs and chimpanzees only in their diminutive stature; and this was associated with the well-balanced human proportions of trunk to limbs; they were, indeed, surpassed by the great orangs and gorillas in the size of the trunk, and in the length and strength of the arms in a greater degree than were the more advanced and taller races of mankind.

Dr. Mouatt gave an excellent account of his experience, in conjunction with Dr. Playfair and Lieutenant Heathcote, of the Indian navy, in the expedition which started from Moulmein in Nov. 1857, for the purpose of exploring the coast of the Andaman Islands. They found that the vegetation was of the densest kind. The Burmese told him there were no jungles in their country that could approach them in impenetrability. The sea had encroached some thirty, forty, or probably fifty yards since the year 1791, when the convict settlement, which had been established by this country was abandoned. The savages were implacably hostile. Their crew (that of the expedition) included natives of almost every country in Europe, and on perceiving a group of the natives, they at once rushed to the side of the boats to see if the prevalent belief with regard to them—that they had lions' heads and horses' tails, were correct. He took precautions to prevent the natives from supposing that their intentions were otherwise than peaceable, but the male portion of the natives continued to evince their hostility. After noticing various features of the islands, Dr. Mouatt remarked that it might not be uninteresting to the inhabitants of Manchester for him to declare his belief that finer cotton could not be grown than that which might be produced upon the Andaman Islands, when they were cleared. Rice and other articles might also be grown. He believed the particularly savage character of the natives had been caused by the gross cruelty with which they had been treated, especially by the Malays in their attempts to carry off the edible birds nests, &c. to make into soup in China. He much regretted that even in self defence they (the expedition) should have come in collision with the natives, and that several of them were killed. Dr. Mouatt then corroborated the statement made by the traveller Blair, remarking that all he had said respecting the islands was true now as at the time at which it was written; and his universal correctness led them to the belief that a coral reef of eight feet, which they found in the middle passage, had accumulated since his visit. He then narrated the circumstances of the unexpected collision with the natives at Interview Island. Several amusing anecdotes were given respecting the habits and quickness of apprehension evinced by one of the natives who was conveyed by the expedition to India, and was named "Jack Andaman." There was not the smallest possible reason for believing the natives of those islands were cannibals. The one who was captured would cook his food when it was possible to do so. As to the vocabulary which had been drawn up as that of the Andamanners, the captured native did not understand anything of it. This native was afterwards sent home in consequence of his ill-health, and Governor General Canning and his lady loaded him with presents. The President thought that section of the Association was exceedingly fortunate in having such a paper read as that of Professor Owen, and such a man to comment upon it. He admitted the climate was good, but it would be long ere the land could be cleared of the forests, and cotton could be produced there.—Dr. Mouatt was aware that the labour of clearing might occupy a century.

In answer to Dr. Hunt, Professor Owen afterwards expressed his belief that the evidence afforded by osteological and dental examination was much more important so far as it went, than any which was derived from language; also, in reply to a remark from Dr. Culle, he said he considered that the larger characters which he had described with respect to the specimen he had examined, rendered legitimate the conclusions to which he had arrived.—Votes of thanks were given to Professor Owen and to Dr. Mouatt, and a paper was then read by

Dr. Beke, F.R.G.S. "On the mountains forming the eastern side of the basin of the Nile, and the origin of the designation, 'The mountains of the moon,' with a notice of a recent volcanic eruption in the Red Sea."

The following papers were also read:—By P. O. GALLAGHAN, Esq. B.A. secretary of the Philosophic Society of Leeds, on "Cromlechs and rocking stones considered ethnologically;" and by BATH C. SMART, Esq. "Remarks on the English gipsies and their dialects."

SECTION F.—ECONOMIC SCIENCE AND STATISTICS.

The PRESIDENT of this section, Mr. William Newmarch, F.R.S. on taking his seat on Saturday morning, announced that it had been agreed to take a short discussion, to be limited to half-an-hour, on the subject of Co-operative Societies. In order to get through the discussion in the time allotted, each speaker was limited to five minutes.

Professor ROGERS led off by saying that he had not any objection to allege against co-operative societies, inasmuch as every one had a right to do what they pleased with their own time and their own money. But he wished to call attention to some of the causes which produced such favourable balances as were represented by the balance-sheets of the various societies. It was obvious that when a co-operative society was established, they commenced with the good-will of their customers, one of the worst difficulties a new trader had to overcome. In the next place, such a society paid nothing for plate glass, and other external recommendations which the ordinary trader needed. Further, the society had to undergo no cost for advertising, and in the next place paid no income tax. The profits of the Rochdale Society last year were said to be £12,000. It was quite obvious that a single capitalist engaged in a business making such a return, would have to pay a considerable amount in the way of income tax, and a large slice would be taken out of the profits. This would account for the comparative profits of these societies; and they seemed likely to be carried on with advantage so far as they were confined to the distribution of commodities; but on the question of the manufacture of articles of fashion, luxury, or option, the case was different. The attention of an eminent financier in the House of Commons had been called to the fact that these societies did not pay income tax.

Mr. R. M. PANKHURST said that Mr. E. Potter in his paper took a view adverse to co-operative societies, and laid great stress upon the fact that they had not that unity of council, and decision of action and proper concentration of authority, which they should have in individual cases. But this same objection would apply to all joint-stock companies and every system of associated and concerted action. Mr. Potter's paper seemed to be an attack upon democratic institutions rather than upon the principle of co-operation. But it was further said that these societies had not been sufficiently long before the public to afford a test of the practical success of the movement; and this was in the face of brilliant and conspicuous success. The Rochdale Society began under circumstances of poverty and depression; it was the first instance of such an experiment on an extended scale; and to urge that it was exceptional, as Mr. Potter had done, was somewhat unfair. The advocates of the system of co-operation ought to be prepared for prophecies of disaster and jealousy of success; but neither of these ought to deter them from carrying on a work which had hitherto been productive of such inestimable benefits.

The Rev. W. N. MOLESWORTH said that the reason co-operative societies were not liable to income tax was because all their members had not sufficient income to make them liable. The principles of the societies which distinguished them from ordinary joint-stock companies, were—1st, that they aimed to make the improvement of the material condition of the working-classes the basis of their social and intellectual advancement; secondly, that they neither gave nor took credit; and thirdly, that they kept the governing body under the constant and vigilant superintendence of the proprietary on the spot; the greater part of whom were acquainted with the nature of the business they had to control.

Mr. N. M. TARTT said he thought these societies had been rather hardly dealt with by the Legislature, inasmuch as the same protection was not afforded to them as there was to companies under the Limited Liability Act. They had not yet had any experience of these societies in periods of depression, and he was afraid that some members with accumulated savings would find themselves placed in an awkward situation, because they had not the same protection as was accorded to other societies of a similar nature. Small traders complained of these societies; but he presumed that the same consideration would be applied to them as was applied to turnpike roads when railways were originated.

Mr. CLARKE thought that co-operative societies would be more likely to tide over times of difficulty than limited liability concerns.

Mr. T. WILSON said that a paper was read on the previous day relative to the danger to Athenæums, &c. arising from the establishment of co-operative societies. Mr. Tidd Pratt would not register any society which had a clause in its rules allowing the appropriation of funds for the purposes of education. Rochdale appeared to have got theirs on the sly, and before it was known that such a thing was illegal.

Mr. H. PITMAN, editor of the *Co-operator*, said that Mr. Slaney had brought in a bill whereby the anomaly would be remedied, and a working man would be allowed, if he pleased, to tax himself for his own benefit. He repudiated the notion that Rochdale had got their rules passed "on the sly." He had every reason to hope that next session Mr. Slaney's bill would pass.

Dr. J. WATTS said that co-operative societies were registered under the Friendly Societies Act, and societies so enrolled, it was well known, were not subject to income tax. In regard to Athenæums, &c. he did not think they had any right to complain if the working men did establish literary institutions of their own. In the present day, there could not be too great facilities for intellectual culture.

Mr. AKROYD, as a manufacturer, disclaimed any feelings of irritation or jealousy, consequent on the establishment of co-operative mills, but did not believe in their success. He should like to see the relation of master and workman so altered as to give the latter a share in the profits of the concern.

The PRESIDENT said he thought the law of partnership ought to be so altered as to allow a capitalist to give a commission on profits to his workmen, without necessarily making them partners. A bill having that object was introduced into the House of Commons three years ago; but, from some accident, it failed. For his own part, he thought that *a priori* reasoning seemed to be against co-operative societies undertaking manufacturing pursuits. At the same time, he was quite anxious to be convinced by facts that co-operative societies were competent to undertake even the more complex branches of manufacture and commerce.

Dr. J. WATTS said he had recently seen a decision that a partnership consisted in sharing in the losses as well as the profits.

Mr. AKROYD: But the state of the law was so utterly uncertain, that no manufacturer would be justified in trying it for himself.

The PRESIDENT: An act of twelve lines would do all that is necessary.

The discussion was closed, in consequence of the half hour having elapsed.

THE MANCHESTER GASWORKS.

Mr. J. SHUTTLEWORTH then read his paper, entitled "Some account of the Manchester gasworks." Manchester was the first place in which the regular and complete application of gas for economical purposes was successfully tested. This was effected under the direction of Mr. William Murdoch, in 1805, at the cotton mill of Messrs. Phillips and Lee, and had made Manchester a sort of starting point in all historical notices of the subject. Their townsman, Dr. Henry, was the first to direct attention to the purification of gas; and, further, the act

5 George 4, c 133, which passed in 1824, under which the Commissioners of Police for Manchester were authorised to establish gasworks for lighting the town was, he believed, the first act ever granted by Parliament that empowered a municipal body to apply public funds to the carrying on of a manufacturing business for the benefit of the public. Until that act was obtained, it was an established principle in the legislation of this country not to permit public bodies to become traders. It appeared then, that in connection with gas Manchester enjoyed the distinction of being the locality where its practical use on a large scale was first shown, of ranking among its citizens the eminent chemist by whose researches its purification was effected, and of removing the Parliamentary restrictions that prevented municipal bodies from deriving profits for public use as from its manufacture. The Commissioners of Police, who managed the affairs of the town under an old police act, the 32d George III. which passed in 1792, began the public use of gas by fixing a single lamp over the door of the then police office in Police-street, at the bottom of King-street. He well remembered the crowds that night after night gathered in front to gaze at it. As the use of gas spread, its superiority to all other light made the public axious to obtain it for private consumption, and several public meetings were held for the purpose of urging the Commissioners of Police to extend the works so as to supply the general demand. The Commissioners made an appeal to the leypayers at large; and at a meeting held on the 30th of April, 1817, it was resolved:—"That it will be expedient to adopt the proposed mode of lighting the central parts of the town with gas, and, for the purpose of effecting this object, to raise the police rate from 15d. to 18d. in the pound." The gas works were enlarged, a "Gas Committee" was established; but as the right of the commissioners to sell gas to private consumers was uncertain, it was thought desirable to obtain a special Act of Parliament to legalise what had been done and to give power to continue the works, prescribing the application of the funds derived from them. While the commissioners were preparing their measure, a notice appeared on the 20th September, 1823, from persons entirely unknown in Manchester and without any previous intimation of their intention, to apply to Parliament for a bill to authorise the establishment of a "Manchester Imperial Joint-stock Oil Gas Company, to light with oil or other gas the town and parish of Manchester." On this notice appearing, measures were taken to oppose the project, and at the same time to promote the previously intended purpose of obtaining a gas act for the town. In furtherance of these objects meetings were held in Manchester, Salford, Ardwick, and other townships of the parish. Though the opposition to the Oil Gas Bill was thus formidable, the promoters continued their efforts, and might have succeeded, but in getting up petitions in favour of the bill they had resorted to the grossest fraud in attaching forged and fictitious signatures, and on these frauds being proved to the committee by the clearest evidence, the committee to which both bills had been referred at once indignantly rejected the Oil Gas Bill and adjourned without making any report, alleging that they dispensed with this customary formality from a motive of mercy to the parties, inasmuch as they could not make a report without bringing the authors of the fraud and contempt to justice. So strong and general was the indignation excited in the House that on an attempt being made a few days after to revive the committee, the motion was negatived, not in the usual way by a quiet orderly vote, but as it is stated in the newspaper reports of the time "by a thunder of Noes." The resentment thus provoked by one party had, perhaps, a reactionary influence in favour of the other, for the defeat of the Oil Gas Bill was speedily followed by the passing of the Manchester Act, thereby practically recognising the principle that such establishments might be created by public funds and conducted by public bodies for the public benefit; and further that the object to which gas works especially are subservient is more likely to be secured by a general establishment conducted under effective public control by a public body, than by any private association founded solely for private gain; in short, that such establishments are not only legitimate in principle, but are even the best, because the most certain and convenient means of effecting those most important public improvements which progress and circumstances make necessary in towns, which might not be otherwise effected. The act unfortunately left the constitution of the body which under the act of 1792 governed the town, and from which the gas directors had to be chosen, unaltered. The governing body was not composed of a limited number of persons chosen as representatives, but was constituted of all the inhabitants who paid a rent of £20 a year. Under such a system it was clear that whenever there was a strong collision of opinion on public questions, persons on both sides would qualify in such numbers as utterly to destroy the deliberative character of the public meetings that might be held In the proceedings both with respect to gas and other public affairs, that took place for years after the passing of this act, so great was the excitement that prevailed that crowds of qualified inhabitants became Commissioners of Police, and for a long period the meetings that were held were characterised by the most disgraceful turbulence and disorder. At one meeting alone, in 1827, no less than 665 persons qualified as Commissioners. At these meetings the most extravagant propositions were brought forward, such as, for instance, that gas should be supplied to consumers at cost price. The parties most prominent and offensive in this violent agitation were chiefly the lowest class of shopkeepers and publicans. Then followed an agitation for the sale of the gas works; but this was eventually suspended by the appointment of the late Mr. Thomas Wroe to the comptrollership of the works. This was quite an epoch in the history of the works. In the first year Mr. Wroe reduced the price 5 per cent, and raised the production from 88 millions of cubic feet to 96 millions, or 9 per cent, and increased the profits from £10,200 to £13,500, or 34 per cent. In the ten years that Mr. Wroe was connected with the works he reduced the price from 10s. 6d. to 5s. 9d. and raised the annual profit from £10,200 to £31,700. The benefit derived by the town from Mr. Wroe's services amounted to an annual sum of £45,416. This was stated in a report of the Finance Committee, bearing date August 22, 1842, which he thought ought to be published for general circulation, as it contained particulars of the services of one who had not yet had justice done to his unparalleled work as a public servant. For the introduction of the Municipal Corporations Act to Manchester they were indebted to Mr. Alderman Neild, who originated the movement, and was untiring in his exertions until it was accomplished. The Municipal Act, among its many other advantages, gave a security and permanence to the gas establishment which it could not be considered to possess previously. The consequences had been highly important. To the inhabitants it had supplied the best and cheapest light that exists. To the public at large it had contributed regularly funds for widening old and forming new streets to an extent that had afforded needful accommodation for the vast increase of traffic, of population, and merchandise, that had grown up among them, and which, without such aid, would probably have been actually prevented by the want of space in the streets and thoroughfares, which was essential to its existence. In both social and political economy, facility of communication and transit was one of the most important elements of national prosperity, and demanded unceasing attention to every available means for securing it. In this respect the Manchester gasworks had been especially useful. Before their establishment it was the standing and universal reproach of Manchester that it was the worst and most inconveniently built town in Europe. It possessed no fund for general improvements, and was so rapidly increasing as to make from day to day the necessity of such a fund more alarmingly apparent. Without the funds derived from the gasworks, the physical necessity of wider and shorter streets would either have put a stop

to the growth of the traffic, or have rendered absolutely imperative a resort to large improvement rates, thus not only most injuriously affecting the value of property throughout the town, but also checking and depressing all other interests. Such were the exigencies of the town in this respect that at a meeting of the Commissioners of Police in 1827, a scheme of necessary improvements to meet the rapidly advancing wants of the community was brought forward which involved an estimated cost of from one to one and a half million sterling. He thought it was a happy circumstance for Manchester in a threatened necessity of such vital importance to its prosperity that a fund existed in the profits of the gas works of sufficient magnitude to equal the demand. That these estimates were not overrated, was clear from the fact that in addition to improvements still in progress and still wanted, the payments from the gas profits for the purposes then contemplated have amounted to more than £700,000, besides debts incurred that were yet owing. In the first year of the establishment of the gasworks the profits amounted to £263. 10s. 5d. In the following seven years they amounted to £20,000, and of this, £15,000 to £17,000 was paid towards the erection of the Town Hall. From 1825 to 1839 inclusive—from the date of the first gas act to the grant of the charter, a period of 15 years—the profit was nearly £172,000, or an average of £11,500 a year; and from 1840, when he became a member of the gas committee, to 1859, when that connection ceased, a term of 19 years, they amounted to £660,000, or an average of nearly £35,000 a year, or treble that of the preceding 15 years. The price to the consumer during the same period had been reduced from about 16s. to 4s. 6d. (in 1859) per 1,000 feet; and but for a resolution of the Town Council in 1851, by which one half of the profits was diverted from improvements to relieve the water rate, would certainly have been reduced ten years ago to a medium of 4s. per 1,000 feet. According to the last publised report of the Gas Committee, to June 24, 1860, the amount of capital in the gas works was £501,326; gas produced in the year ending June, 1860, 779,150,000 cubic feet; rental, £154,658, which was equal to an average charge of about 3s. 10¾d. per 1,000 feet. The price of gas within the city is from 3s. 8d. to 4s. or a medium of 3s. 10d. The cost of cannel, £56,177, equal to 1s. 3½d. per 1,000 feet; cannel consumed, 76,039 tons, which showed a production of 10,240 feet per ton. By the Gas Committee continuing to attend to the quality of the gas so as to secure the highest purity and illuminating power, and by the council so regulating the price by fixing it at as low as was commensurate with the capital employed and the business done, they might expect not only a continuance but an augmentation of the benefits of which it had been a certain and important source.

Mr. Alderman NEILD paid a high tribute to Mr. Shuttleworth's services on the Gas Committee.—Mr. E. CHADWICK had always held up the Manchester Corporation as an example to other municipalities; and he suggested that the circulation of Mr. Shuttleworth's paper among the various towns in the kingdom might prove of great advantage.—A Member of the Association eulogised the purity and illuminating power of the Manchester gas.—Professor ROGERS compared the condition of affairs in Manchester with what was observable in Oxford. In the latter place, the company was bound by law to pay over profits, beyond a certain amount, to the Commissioners of Lighting and Paving. They not only provided the worst gas in England, but infringed the Act of Parliament in every conceivable way. The only plan to compel them to do their duty he supposed was by filing a bill in Chancery, and they all knew what that meant, — immense expense, prodigious delay, and a doubtful termination. Mr. LEIGH described the process by which the purity of the Manchester gas had been secured.—Mr. SWALLOW said that on the 29th of September, 1860, there were 4,467 cellar dwellings in Manchester; and of that number 3,884 were actually inhabited. If the Corporation could persuade the owners of cellar property to allow the cellars to be lighted with gas, better ventilation would be secured, and the health of the people thereby improved, and it would prove a good police adjunct, as it was well known that light was abhorrent to crime.—Dr. FARR advocated the publication of the paper with a view to other corporations being made aware of the success which had attended the lighting of the town being in the hands of the authorities.—Mr. DYSON differed from Mr. Shuttleworth on the gas question, and contended that gas ought to be supplied to the inhabitants at cost price.—Mr. MEDCALF said there were other objects to be accomplished by the Corporation than providing cheap light, such as draining and making provision for the preservation of the public health. This could not be done if the gas was sold at cost price.—The MAYOR of Manchester said that the Gas Committee were as far as possible extending the supply of gas into cellar dwellings, both by hiring out meters and supplying fittings. Their anxiety was to do away with cellar dwellings altogether.—(Hear, hear.) But this would be a work of time. As to supplying gas at cost price, he did not think that quite feasible. The Corporation rather wished to supply a good article cheap, and at a moderate profit. He thought it would be advantageous to communities to buy up existing companies; but there were difficulties in this, as illustrated by the case of Bolton, where the existing shareholders contended for a guarantee of ten per cent.—The CHAIRMAN said it seemed to be the opinion of the meeting that the best means should be taken for having Mr. Shuttleworth's paper printed and copies of it sent to the different municipalities in the country. The Committee would meet on Monday morning, and would consider the best means of accomplishing that object, so that the valuable facts which the paper contained might come before the public with whatever advantage could be conferred upon them by the high approval of that section. He was glad to find that the long labours of Mr. Shuttleworth were so largely appreciated in the town. On general principles, no object could more fittingly be placed under municipal control than those of light and water, and amongst the many other obligations they owed to Manchester must be added that of having showed an example in this respect.

FACTS AND STATISTICS ABOUT WORKHOUSES.

Miss LOUISA TWINING read a paper to which she gave the above title. Miss Twining commenced by saying that in 646 unions and workhouses in England and Wales there were on the 1st of January 113,507 inmates, of whom 30,654 were children in pauper schools. The whole number of indoor and outdoor poor was 850,896; and of those who were called able-bodied 40,000 were males, while above 110,000 were females. Thus a large proportion of our destitute pauper population was composed of women and children; in many workhouses they were two thirds of the inmates. The returns of the Poor Law Board gave but scanty information, and with regard to particular workhouses, details were not published. The number of deaths in the course of the year might be ascertained from the reports of the local inspectors of health, but they found no details as to the ages and causes of death. Thus, those who paid the rates, and ought to be interested in the mode of their expenditure, as well as in the welfare of those who were supported by them, knew nothing whatever about it. The one medical man who visited the workhouse, and the Guardians, were the only persons who knew anything about the state of things or the condition of the inmates. With a view of enlightening and interesting persons in these various large and important institutions, she would suggest that reports should be annually published, containing accounts of the numbers and classes of the inmates, the length of time they had been such, and, what would be the most important of all, the causes of death. This would give the information which now they had not, about the mortality of infants and children in workhouses, about which much was surmised, but little was known, from the impossibility of obtaining facts. In short, what she was anxious to urge was the admission of more daylight generally into workhouses which would soon result

from a more general interest in them. Subscribers to hospitals and other institutions wished to know how their money was spent, and what the management was; and why should not ratepayers wish to know what was done with the money they contributed? It was not only desirable but a positive duty to do so; and it was to be hoped that the interest, now partly awakened, might soon become more active and beneficial. The tide of sympathy and benevolence which had reached to the very lowest and apparently to the most hopeless depths of the social system, could not fail to penetrate in time the recesses of our workhouses, where thousands of our poorest and most suffering fellow-creatures were maintained, but about whom so much ignorance and still more indifference prevailed. Here was one of the widest fields yet opened in our country for the exercise of woman's sympathy and help. Hitherto, both had been practically ignored in these institutions, the management being entirely in the hands of the guardians, and frequently the only responsible woman in authority being the paid matron, who was expected to control and manage the house and all the inmates, however numerous they might be. It was now six years since Mrs. Jameson directed attention to the claims of women to an influence over persons of their own sex in institutions. Whatever the faults of the inmates of workhouses, they stood in need of woman's help and sympathy, probably all the more deeply because women only could be the reformers of their own sex, and if vice had directly or indirectly brought these women and children to the last refuge of the destitute, there was the more urgent call for those of their own sex to come forward to their rescue. This was the position taken by the Workhouse Visiting Society three years ago. During the Crimean war hospital nurses were thought to be bad enough; but the workhouse nurses were almost invariably many grades lower still, because no remuneration was permitted for them. The most helpless cases failed to receive attention except through giving bribes to the nurses, who hovered around visitors to the patients in the hope of procuring gifts. The condition of the young was fully as important as that of the sick, and Miss Twining advocated the desirability of separating the decent and respectable girls and women from the corrupted and depraved—a point which had never yet been attended to as it deserved. The experience of nearly six months in the Industrial Home for young women opened by the Workhouse Visiting Society in London proved that a respectable place was needed for girls in the intervals of changing their situations. During that period 30 had been received, and from eleven workhouses alone. Of these 20 had been in pauper schools of some kind, and not having lost their character were not fit inmates of the wards in workhouses where women of all kinds congregated without distinction. One girl declared that she had never heard such language as greeted her ears in the ward of a London workhouse, to whith she was transferred on leaving her place; and another girl, of 16, who proclaimed her intention of leaving the ward for the worst of purposes, said she had gained her information from women in the ward; and it was well known that the elder women, who were invariably the worst, took a pleasure in corrupting the minds of the younger ones. Guardians should have the power to pay for girls in institutions where there might be some hope of their remaining uncorrupted. At present there was no sufficient agency for doing this whilst they were in workhouses. The admission of a higher and better influence was the only hope of improvement that existed, and why such an agency should be so frequently rejected was surprising; for it was obvious that to improve the morality of the inmates was to enable them to lead a respectable life out of doors, and to get them off our hands. Yet this seemed to be entirely overlooked by the jealousy of some officials as to "interference," so called. She did not urge an indiscriminate and unauthorised admission of visitors to workhouses. That had never been the proposal of the Society to which she belonged. That might have caused confusion and inconvenience, but never had their plans done so when properly carried out, but they had always ministered comfort to the inmates, and contributed to the peace of the house.—Miss Twining was loudly applauded on concluding her paper; but the Chairman decided that no discussion could be taken upon it, as it did not properly fall within the scope of the labours of the section. They felt they could not resist Miss Twining's claims to attention; but, after thanking her most heartily, they must pass on to the next paper.

TRADE OF ENGLAND WITH CHINA.

Colonel SYKES, M.P. read a paper entitled "Notes on the progress and prospects of the trade of England with China since 1833." Our present and prospective relations with China, both commercial and political, were so highly important, and involved such serious consequences, that a few observations on those subjects might neither be inopportune nor uninteresting. Whether our past policy towards China had been justifiable or not, the extension of our commercial relations with the Chinese was sufficiently remarkable. In the year 1814 the total amount of imports and exports on British account was about 5¾ millions sterling. In 1826 the value exceeded seven millions, and for the last five years of the East India Company's monopoly the average value of the Company's and the private trade in which they permitted their servants to engage, approached to ten millions sterling. Since the act of 1833, which deprived the East India Company of their monopoly, as might be expected, a rush of competing interests had increased the trade since 1834 fully fourfold. In 1856, according to statements which appeared in different numbers of the Hong Kong government *Gazette*, the value, independently of the opium trade with India, amounted to £17,526,198. In 1857 the imports were £4,783,843; but the exports were £12,742,355. So far as the legal trade was concerned, the exports trebled the imports; but there was another article of commerce of which there was no official record kept. He referred to opium, which in 1857 amounted to four millions. Still the exports exceeded the imports by nearly four millions, which must have been paid to China in silver; but as the balance of trade between India and China had always been in favour of India, most of the silver from Europe found its way to India through China in payment for opium, and this fact assisted to account for the silver which poured into India annually, and did not leave the country again. From the years 1834-35 to 1858-59, India received £123,143,696, in bullion, of which only 19 millions left the country again. A remarkable progress had taken place in the export trade of Shanghai—a fact which presented some anomalous and conflicting considerations. Since the year 1853 the rebels or Taepings had been in possession of Nankin, the ancient capital of China, and of several great tea and silk producing provinces in the Yangtsze Kiang; and Shanghai had to be supplied either from these provinces or from provinces beyond the rebel territories and still under the Tartar authorities, but whose products would mostly have to pass through the rebel territory to reach Shanghai. A portion of the Europeans in China had exhausted damnifying epithets in reference to the rebel character and proceedings. They were "blood-thirsty brigands," &c. He was not an apologist of the rebels; but he could not refrain from asking himself how it was that the trade of Shanghai could have flourished in the way it had done if the accusation were literally true. Annually increasing quantities of tea and silk could not be produced from "howling wastes;" and those products, if for the most part coming from provinces under Tartar rule, must have passed unmolested through Taeping territories; though as brigands they would have plundered them. The Taepings professed to have a Divine mission to extirpate the Tartars, their foreign rulers, and to destroy idolatry; and in prosecuting these objects great atrocities must have been perpetrated; but in respect to the rural population as contra-distinguished from the Tartars, the fact was patent that when unexpectedly repulsed in their attack

upon Shanghai, in August, 1860, by French and English troops, although exasperated by a sense of betrayal in their retreat, they left uninjured the standing crops around Shanghai, and they did not molest Europeans. The nature of the paper would not admit the discussion of the conflicting opinions promulgated respecting the character and conduct equally of the rebels and of the Tartars. There could be no doubt that they practised towards each other the most revolting atrocities, such as were the usual accompaniments of civil war exasperated by religious fanaticism. He could only consider the question in relation to the prospects of the British trade with China. The expenditure of British blood and British treasure in three successful wars had extorted from the Tartars all the facilities that the British trader desired to have, leaving, however, in Tartar breasts a burning resentment at the degradation of the Imperial goverment, and in Tartar officials a manifest disposition to obstructive subterfuges in carrying out the treaty of Tien-tsin. The Taepings or rebels on their part issued proclamations professing amity for foreigners, calling them "Christian brethren," and inviting them to enter into commercial relations, but with one exception. The traffic in opium they denounce as a religious ordinance, and threaten the penalty of death to those who engage in it. The taxpayers of England, therefore, would have to determine whether we were to tread in our former steps, and, for one article of commerce, waste life and money to force upon a reluctant people, for selfish gain, a deleterious product; while, at the same time, we crushed a national movement to throw off a foreign oppression, which under analogous circumstances in Europe had had our warmest sympathy, and at the success of which all freemen rejoiced. — (Cheers.) A long discussion ensued, in which Mr. J. CHEETHAM pointed out the difference between the treatment of foreign traders by the so-called rebels and the Imperial government in China. He thought our ambassador in that country was pursuing a most unwise policy when under a profession of neutrality he was countenancing the Imperial government.—Mr. DAWSON gave an interesting account of the "rebel" camp which he had received from his son, who was in that country as an agent of the London Missionary Society. — The CHAIRMAN having ably reviewed the whole question of our Eastern commercial relations, the discussion closed with a vote of thanks to Colonel Sykes.

PAUPERISM.

Mr. FREDERICK PURDY read a paper on "The relative pauperism in England, Scotland, and Ireland, 1851-1860." The paper treated of the relative pauperism of England, Scotland, and Ireland during the ten years ended in 1860. It pointed out that each country had its own poor laws, and its separate administrative machinery. Poor laws had existed in England for more than two centuries; but in Scotland there was nothing worthy of the name before 1845; and, in Ireland they were introduced in 1838. In England the average number of paupers was 892,000; in Scotland, 121,000; in Ireland, 96,000, or 3·9, 4·0, and 1·5 per cent on the population respectively. Those who had devoted themselves to study the working of the English poor laws, were opposed to the system of "outdoor relief," from the difficulty of testing the applicants' claims and from the fear that it may be perverted to the depression of wages. It appeared that for 1 indoor pauper in England there were 6 outdoor, in Scotland 14, but in Ireland ·03 only. Though pauperism is lowest in Ireland, it was shown that in Scotland, where nearly all the relief is outdoor, the resident Irish were greatly pauperised, for 1 in 13 was there a pauper; but in Ireland only 1 in 2.74. According to the most recent statistics, there were 43,810 pauper lunatics in the United Kindom: England having 33,068, Scotland 5,103, and Ireland 5,639 of this unfortunate class. In each 10,000 of the population, England has 17, Scotland the same, and Ireland 9 only. The Commissioners who in 1858 reported upon the Irish Lunatic Asylums, stated that there were 3,350 "insane poor at large and unprovided for." This would, if they were to be included hereafter as paupers, raise the Irish ratio considerably. In the ten years £92,000,000 had been raised in poor rates: In England £78,000,000, Scotland £6,000,000, and Ireland £8,000,000. But of the English portion £18,000,000 were for purposes quite unconnected with relief to the poor. The sums actually spent for the relief of the poor were—for England £54,767,000, Scotland £5,918,000, and Ireland £6,656,000 respectively; equal to a rate per head on the population of 5s. 9½d. 3s. 11½d. and 2s. 1½d. The proportion was nearly treble in England, and double in Scotland, that which sufficed for Ireland. Comparing the amount expended in 1860 with that of 1851, it appeared that in England it was now 10 per cent, and in Scotland 25 per cent higher; in Ireland, on the other hand, it was now 60 per cent lower. The yearly cost per pauper was, for England £6, Scotland £5, and Ireland £7. Ireland stands higher here, because, relief in the workhouse is dearest individually, though in its ultimate effects, the most economical and the least demoralising. As to the rate in the pound on the property tax assessment, a comparison was made in respect of the seven years ending in 1860—there being no return for Ireland previous to 1854. The relief to the poor during that period was equal to an annual tax, on the schedule A assessment, of 1s. 1d. in England, 11½d. in Scotland, and 10¾d. in Ireland. It was considered remarkable that, however diverse the pauperism of the three kingdoms had otherwise been, yet, in this relation, there was considerable uniformity, England only exceeding Scotland by 1½d. and Ireland by 2¼d. in the pound. The rate per head on the population of the assessments under schedules A, B, and D, was computed to show the relative wealth of the three countries; this, in England, was £11. 17s.; in Scotland, £9. 13s.; and in Ireland, £3. 11s. Taking these figures in conjunction with previous ratios, it would appear that the pauperism has been inversely as the poverty of the three countries—England the wealthiest and most pauperised; Ireland the poorest and least pauperised; Scotland coming between, but much nearer to England in wealth and in pauperism. It was asked, in conclusion, if Ireland, under the judicious administration of her poor laws, has reduced her pauperism to a quantity which, at the present day, is less than 1 per cent of the population, under what conditions can we hope that similar results may be achieved for England and Scotland? But it was observed that something beyond statistical information is required for the satisfactory solution of this important question.

In the discussion which followed, Mr. E. CHADWICK expressed an opinion that the benevolent suppression of vagrancy would tend to the reduction of pauperism.—Mr. SENIOR advocated outdoor relief as very seasonable and proper in many instances.—The Rev. J. H. RIGG believed that pauperism was a curable evil; and their object should not only be to conduct the overflow of the reservoir, but they must look a great deal deeper. He believed and hoped that ere long pauperism on a great scale would be an exceptional case. He instanced the case of Guernsey, where there were hospitals but no paupers, and the reason was that every man saved and screwed, and even deferred marriage—an elysian state of joy which many political economists wished—until they had a house and freehold of their own. He hoped by co-operative and building societies, by the spread of temperance and religion, pauperism, which in a country like this was an abnormal and anomalous thing, would be obviated.—Mr. BRACEBRIDGE pointed out that in Ireland medical relief did not constitute a pauper, whilst it did in England. This might account to some extent for the apparent difference. He, as a chairman of a board of guardians, was an advocate for persons having a right to visit and criticise the arrangements of workhouses, but they should exercise no authority.—Professor ROGERS strongly condemned the law of settlement.—Mr. RAPER pointed out that the Beer Bill had not extended to Ireland, and to this he attributed the reduced rate of pauperism.—The PRESIDENT: If they have not their beer they have their whisky.—(Laughter.)—A vote of thanks was passed to Mr. Purdy.

THE HEALTH OF THE ENGLISH ARMY.

Dr. FARR read a paper on this subject. Lord Herbert, he said, in the prime of life and in the midst of his labours to improve the health of the British army had died, and his loss had been felt by all his countrymen, who were never slow to recognise the services, or to do homage to the worth, of their departed statesmen. The defects of the health of the army, which had been before manifest in the figures of returns, struck every heart when they appeared in the thinned ranks before Sebastopol, in the sick-freighted ships on the Black Sea, and in the hospitals of Scutari. Mr. Herbert, from his position, felt the defects perhaps more acutely than any, and since that time, neglecting ease and enjoyment which a splendid fortune placed at his command, he devoted himself to the sanitary reform of the army; first in a royal commission appointed by the government of Lord Derby; then in commissions for carrying out its recommendations, and lastly as Secretary of State for War. Notwithstanding the heavy duties of that office he continued to act on a royal commission of which Lord Stanley is the chairman, and some of his last recorded words were inquiries into the means of saving the numbers of soldiers who are destroyed in hundreds every year by the bad sanitary arrangements, rather than by the climate, of India. His frank and winning manner, his knowledge of his subject, and his eloquence, enabled him to overcome many obstacles, and he had some courageous colleagues, among whom he (Dr. Farr) must name as the foremost, Florence Nightingale—(cheers)—who shared, without diminishing, his glory. Sidney Herbert was animated by the feelings of him in his ancestral line, who, when he lay upon the battlefield, and when fainting and thirsty from the loss of blood, resigned the glass of water to the dying soldier with the words, "Thy necessity is greater than mine." Lord Herbert loved the soldier so well that for his sake, and to promote the efficiency of the British army, he would willingly have laid down his own life. Happily before his death he witnessed some of the results of his measures; he saw the marvellous success of the China expedition; and he received the first annual report of the Director General of the medical department of the army, showing "a remarkable reduction in the mortality of all classes of troops." Lord Herbert was not satisfied with pointing out evils in a report. He got commissions of practical men nominated by Lord Panmure, placing himself at their head, to remedy those evils. The labours of one of these commissions were described in a recent report by Dr. Sutherland, Dr. Burnett, and Captain Gatton, and its measures for improving the sanitary condition of barracks and hospitals were so well conceived that they deserved to be studied by all who took an interest in the health of armies. The sanitary report of Dr. Logan and the medical report of Dr. Mapleton, with the accompanying papers, proved that sanitary and medical science had much to expect from medical officers. The Commission for carrying out improvements in the vital statistics of the army laid down an elaborate and yet simple plan for the observation, record, and analysis of sickness, diseases, and casualties, of the army under various circumstances at home and abroad, in peace and in war. That plan was now in operation. He trusted the remarkable weekly reports would soon be promulgated, showing, as they did, very marked contrasts in different regiments. Having quoted returns to show that a manifest diminution had taken place in the mortality and sickness of the army, Dr. Farr continued by saying that upon examination it had been found that the great causes of the excess of deaths in the army were completely under control in all ordinary circumstances; and as they varied, their effects varied. If the measures that had been begun were completed, there was no doubt of the result; and if the causes of disease were studied under the new system of observation established by Lord Herbert, improved means of guarding the mechanism of the human frame would be discovered, and would accumulate year by year. As modest in death, Lord Herbert lies quietly in his tomb at Wilton; and what memorial, either in bronze or in marble, it might be thought right by his friends or his country to dedicate to his memory was not known; but—he (Dr. Farr) ventured to affirm—that which would be dearest to his soul, and which occupied the solicitude of his last hours, was the continuance of the good work which he had inaugurated.—Mr. BAZLEY, M.P. in moving a vote of thanks to Dr. Farr, said he attributed much of the pulmonary and chest complaints from which many soldiers suffered to the pipe-clay cross-belts, which were too often left to dry on the human drying machine. The buckskin "inexpressibles" of the Horse Guards he also considered injurious to health, and often fatal to life.—Mr. BRACEBRIDGE attributed much of the good effects which had resulted from Lord Herbert's measures to his appointment of a sanitary officer over every force in the British army.—Mr. E. CHADWICK thought greater attention should be paid to the draining and ventilation of barracks. A sanitary engineer ought to be appointed.—After passing a vote of thanks to Dr. Farr, the section adjourned.

SECTION G.—MECHANICAL SCIENCE.

At the resumed sitting of this section in the Peter-street Schools, on Saturday; Mr. J. F. BATEMAN, the president of the section, took the chair; and, in opening the proceedings, expressed a hope that, though they were going to discuss shells and other explosive materials, the discussion would be conducted quietly and without any warmth of feeling.—(Hear, hear.)

RIFLED ORDNANCE AND IRON PLATES.

DR. EDDY read a paper entitled "A proposal for a class of gunboats capable of engaging armour-plated ships at sea; accompanied with suggestions for fixing the armour plates." He said an idea had certainly obtained some currency, that the heavy iron-clad ships which we were engaged in constructing at such a prodigal expense might be assailed with some chance of success by vessels very inferior to them in point of size and cost, but especially designed for that service. With the view of determining this important question, he had been invited to bring before them some ideas and suggestions of his own, in the hope of eliciting the opinions of those most competent to form a judgment. He considered there were some grounds for the apprehension that this might be effected, and he held that, before engaging in such an expensive rivalry of building, ship for ship, such huge vessels as our neighbours were building, we should do well to pause and satisfy ourselves whether at a much smaller cost, and in a much shorter space of time, we might not construct a fleet of small ships that would paralyse these monsters, if not destroy them, and which, as they would be numerically superior, would be a more reliable guard to stand sentry round our island than a few large ships however formidable in themselves.—(Hear, hear.) It was obvious that the first essential condition of vessels such as he contemplated was superiority of speed over the enemy. It seemed almost superfluous to mention this, but it appeared to have been forgotten in many recent inventions. A second indispensable condition was such an amount of protection as should enable a small vessel to come to close quarters with a large ship and strike home without getting the worst of it. Granted superior speed, and he maintained that vessels of small force could do anything with vessels of vastly superior weight of metal, provided they could be so protected as to approach near them without being crippled or destroyed. If able to do this, they need not confine themselves to the uncertain practice of artillery, but might probably make use of far more murderous weapons, against which armour would be of no avail. But, other means apart, and relying on artillery alone, he believed it probable that one swift vessel with a couple of heavy guns might so harass a large ship of inferior speed as to paralyse her movements, and that two such vessels might even engage her with advantage; and, if this was so, might not a flotilla of these small vessels ad-

vantageously engage a fleet of the large iron-plated ships? To obtain superior speed, we must either sacrifice weight of metal or increase the size. He preferred the former, and by reducing the armament to a very few guns—two or four,—and those of the powerful kind now manufactured, he thought we might obtain the required speed within moderate dimensions; and he hoped to show that, by a peculiar adjustment of material, we might gain all the protection required, without immoderate weight. Much of this problem had indeed been worked out by Captain Coles, of whose cupola the conical fort, with revolving shield, in the model produced, was a modification. A speed of sixteen knots an hour would, he believed, be sufficient for present purposes, and he took it that this speed might be secured without difficulty in a vessel of fine lines, and of certain proportions, without tremendous size. Dr. Eddy proceeded to describe from a model the kind of gunboat he proposed to build. The dimensions, he said, were calculated from one datum, namely, the least elevation above water at which the guns could advantageously be laid, which he took to be 8 feet. In this position, then, he would place two of the heaviest Armstrong guns, with their muzzles 4½ feet apart, on an inclined side, upon a turntable placed within a fixed conical fort, armour clad, the sides of which sloped at an angle of 45 deg. Above this, for a perpendicular height of four feet, he would protect the guns and gunners with a shield of iron plate, also at an angle of 45 deg. The shape of the fort would be a truncated cone on a cylinder, like an extinguisher upon a candlestick. A second cupola he believed might be added, and this would give an armament of four guns, which, if concentrated upon one point at short range, must have a crushing effect. But, to be of any use, the smaller vessel must be enabled to approach her large antagonist without risk of having a shot sent through her bottom from the enemy's depressed guns. The manner in which he proposed to fortify the gunboat was by keeping all the vital parts well below the water line, and covering them with a deck which would deflect upwards any shot that might reach it. As the boat was only intended to attack ships, not forts, he presumed there was no need to apprehend a shot striking her at a lower angle with the horizon than 7 deg. Still at this angle, to protect the sides of the vessel effectually, the armour must be carried at least 4ft. above water and 3ft. below, possibly more; but as this involved a weight of 300 tons in plating alone, some other method of protection must be sought. He hoped he had found this desideratum in a plan which aimed at carrying out thoroughly the principle of deflection. His plan consisted of an arched deck of inch iron resting upon two courses of timber the extremities of the arch being tied, so as neutralise the outward thrust. He proposed that this should spring at the sides from three feet below the water line, and that the crown should rise amidships up to the water line, the crown being kept tolerably flat, the object being to present so small an angle that even a flat-headed bolt should glance off. The space above the deck and between it and the water line he proposed to pack with some tough and resilient but light fibre, and these qualities he found combined in the cocoanut fibre, which could be easily rendered incombustible by sal ammonia. This fibre would offer a considerable amount of resistance to the penetration of a shot, and in proportion to the resistance would tend to deflect the shot. The exact amount of resistance which this mode of packing would afford could not be ascertained without experiment, but the trial would not be expensive. He might be met with the objection that steel or iron was the substance which offered the greatest amount of protection proportionate to its weight. Granting this, he maintained that there were circumstances under which iron alone could not be advantageously used, and that this was one. Dr. Eddy alluded to the difficulty now felt in securing the iron plates on the sides of the vessels without weakening them by perforating holes, and he mentioned a plan of screwing the plates within a rail-shaped frame, which he said he had been encouraged by Mr. Fairbairn to lay before the section, and which he thought would obviate the difficulty.

Captain BLAKELY, R.A. gave a communication entitled "Artillery *v.* Armour." He said it was now four years since he first developed at Dublin his ideas with reference to the strength and extent of range which might be obtained with a particular description of cannon. He was happy to think that the principle he then contended for had since been recognised by both the English and Spanish Governments to be correct. With great deference to the opinion of Sir William Armstrong, he must state, as the result of his experiments, that nearly every kind of steel he had used was better than every kind of wrought iron. Cast iron, where weight was no objection, he found to answer admirably. Captain Blakely exhibited the drawing of the new Spanish gun, and explained its construction. The diameter of the bore was between six and seven inches; more than half of the gun, he said, was of cast iron, the upper portion of the breech only being formed of rings of steel. Extensive experiments had been made to determine the proper degree of tension for these rings, because on that point depended the efficiency of the gun. If the rings were too tight they burst before the central part, and if they were too loose the central parts burst first, and perhaps left the rings whole. He did not think that any limit could be assigned as to the size which would be reached in the manufacture of guns. He had read that Sir William Armstrong was engaged in the manufacture of a 300lb gun. Sir William was present, and perhaps would state whether this was so. He (Captain Blakely) was trying to make a 600lb gun—(a laugh),—and he did not think there was any insurmountable difficulty in making a 6,000lb gun, or even a 60,000lb gun.—(Laughter.) He believed it could be done, and if it could be done anywhere it was in England. The construction he would propose was that to which Sir W. Armstrong alluded and approved of on the previous day, the coiling of steel wire round a central cylinder. With a 600lb gun of this construction the iron plates would have no chance.—The CHAIRMAN remarked that they had better confine their attention to the 200lb gun, which was all they had got at present.—Captain BLAKELY admitted that with the 200lb gun the iron plates would have the best of it. He had offered over and over again to make a gun of the description he had named at his own expense and place it at the service of the Government for trial, and the offer had been refused.

Mr. FAIRBAIRN, president of the Association, as one of the Committee (of which Sir J. D. Hay was chairman) appointed to conduct the experiments at Shoeburyness, rose to give some of the results of the experiments made. Apologising for his not having been able to prepare a written report, he stated that one of the results of the experiments made was to convince him that, though we had very good iron in this country, yet he did not think that the quality of the wrought iron was quite so good as some produced in other countries. The iron itself was good, but it had not that uniformity of texture which was obtained in foreign countries. Our ironmasters, he believed, were bestowing attention on the subject, and in a short space of time would, he believed, be able to produce such plates as would have a fair chance of resisting such artillery as Sir William Armstrong's. It was the intention of the Committee to do everything they could to resist Sir William Armstrong, and he on his part would of course do everything he could to smash them up.—(Laughter.) In the case of armour-plated ships, it was not only necessary to have plates of sufficient thickness, but to have sufficient resistance behind to resist the deflection caused by the velocity of the shot. In the Warrior and the Black Prince, wood was used for this purpose. His own opinion was that wood was entirely unnecessary, and that every part of the vessel above the water line would be better of iron.—(Hear, hear.) Experiments had been made to test the velocity of the shot from the Armstrong gun, and it was found to be about 1,100 feet per second. Mr. Fairbairn referred to the necessity of securing toughness and homogeneousness in the plates, and also to the de-

sirab lity of securing a better mode of attachment than the present system of using bolts or screws. They had tried experiments with a target composed of iron bars; but they found that the resistance offered was not nearly so great as by the welded iron plates, the bars being broken into p ces. The experiments would be continued, and in a few months the Committee hoped to arrive at a definite result with regard to the proper thickness of the plates, the mode of attachment, and the quality of the iron.—(Applause.)

Mr. E. J. Reed read a long and interesting paper on the iron-cased ships of the British Admiralty. He enumerated and described the vessels at present constructed; and stated that the construction of six other vessels had been determined upon, the contracts for three of this number having already been issued. It was important to observe that, notwithstanding the long delay on the part of the Admiralty before they commenced the construction of vessels of this class, the determination of Parliament to have a fleet of iron-cased ships had even now overtaken the Admiralty, and no experiments on a large scale had yet taken place. The great expense it would be necessary to incur to conduct target experiments on a large scale had probably much to do with the delay. A committee of eminent shipbuilders had lately estimated that the cost of a target large enough to test half a dozen modes of construction would be no less than £45,000, and another £45,000 would have to be expended in the construction of a floating hull on which to place the target. The three new ships in course of construction would be twenty feet longer than the Warrior, fifteen inches broader, 582 tons additional burthen, and 1,245 tons additional displacement; and as the displacement was the actual measure of the ship's size, they would thus be more than 1,000 tons larger than the Warrior.—(Hear, hear.) As the engines of the new vessels were only to be of the same power, their speed would probably be much less than that of the Warrior. This diminished speed was one of the penalties we must pay for clothing both extremities of the vessel with iron plates. Another penalty would probably be a great tendency to chop and plunge in a sea-way. The cost of these new vessels would exceed the cost of those of the Warrior class by £20,000 or £30,000. They would certainly be noble specimens of war ships. A vessel built throughout of iron, 400ft. long and nearly 60ft. broad, enveloped from end to end in armour impervious to all shell and to nearly all shot, furnished with the most powerful ordnance, with ports 9ft. 6in. above the water line, steaming at a rate of 12 or 13 knots an hour, would indeed prove a most formidable engine of destruction. If the present intentions of the Admiralty were carried out, we should have six of such vessels added to the navy in the next year or two. In vessels of this kind all beautifying devices must be dispensed with. Their stems were to be upright, or nearly so, without that forward reach, the "knee of the head," which added so much to the beauty of the present vessels. Their sterns would also be upright, and as devoid of adornment as the bows. It should also be stated, as a distinguishing mark of these six ships, that their thick plate would not be extended to the bow at the upper part, but would stop at the junction with the transverse plated bulkhead, some little distance from the stem, and this bulkhead would rise to a sufficient height to prevent the spar deck from being raked by shot. They would be armed with 50 100-pounder Armstrong guns, 40 on the main deck and 10 on the upper. It was not yet determined, he believed, whether these new ships were to be packed up with teak as in the previous ships, or whether the plates should be 6½ inches thick, without wood. This would not be decided upon until after the termination of the experiments with the large targets suggested by the President and others. All that was yet definitely determined was, that whether the armour be made of iron alone or of iron and wood, its weight should be equal to iron plates 6½ inches thick. He now came to notice a very different class of vessels, of which the hull was mainly timber with armour plated upon it. The Royal Alfred, Royal Oak, Caledonia, Ocean, and Triumph were all vessels of this class. Their length was to be 272 feet, breadth 58 feet, and displacement, 6,839 tons. Each would be fitted with engines of 1,000 horses' power. They were being formed with timber originally designed for wooden line-of-battle ships, but had been lengthened 18 feet. The whole of these ships it was believed, as well as the iron plated ships, would match La Gloire in speed, provided they were fitted with the engines at first proposed. It was necessary to make this proviso, because there was a probability of smaller engines being put into some of them. He could not pretend to compare the French and English ships with each other in detail; but he might mention that a friend of his, who had just returned from France, had furnished him with the dimensions of the Solferino, one of the largest of the French iron-cased ships, as follows:—Length 282 feet, breadth, 54 feet, draught of water, 26 feet, burthen, 6,820 tons. The vessel will be plated with 4½-inch plates, right fore and aft at the water line, and over two decks amidships. With reference to the cost of iron-plated vessels, Mr. Reed said that, assuming the average cost of the ships to be £50 per ton, and the engines £60 per horse power, then the eighteen ships which we were now building would cost about £4,700,000, and their engines above £1,150,000—together nearly £6,000,000 sterling; and when masted, rigged, and fully equipped, £8,000,000 would have been expended upon them. He referred, in conclusion, to the extensive dock changes which this revolution in ship building rendered necessary, and urged the serious importance of at once supplying increased dock accommodation in the South of England for these ships. He argued that whether in peace or in war such accommodation would be required; that it would be in the highest degree perilous longer to defer the establishment of colossal docks on the Southampton Water; and in some other favourable place. At present we had no docks fitted in all respects to receive such ships, whereas the French had many. Mr Reed contrasted the English and French docks; and stated that it had been proposed to increase the French works by the establishment of an immense steam arsenal, protected by a series of impregnable fortresses at Lezardrieux.

Mr. Theophilus Aston read a paper on elongated projectiles. He compared the respective projectiles of Sir W. Armstrong and Mr. Whitworth, giving the preference to the flat-headed bolts of the latter. He stated that no iron plate had yet resisted an 80lb shot from a Whitworth gun, and apropos of the Americans leaving their new armour-plated vessels unprotected below the water line, relying upon no shot being able to penetrate through water, he stated that during the recent experiments at Shoeburyness a Whitworth 24lb shot fired longitudinally went through 30 feet of water, 8 inches of solid oak, and then buried itself many feet in the ground beyond. With respect to ricochet practice, he admitted that the Armstrong sectional shell was well adapted to this mode of firing, but he said it was a great mistake to say that the elongated projectile was unsuited for this purpose. The great battle between projectiles and armour plating was not yet decided, but he believed the victory would ultimately rest with the projectiles.

A vote of thanks to the readers of the papers, proposed by the Chairman, was carried by acclamation.

Sir J. Dalrymple Hay rose, at the request of the President of the Association, to supplement his remarks on the experiments at Shoeburyness with some observations of his own. The Committee, he said, in order to ascertain the best quality of material, the best thickness of metal, and the best mode of manufacturing iron plates, invited the leading manufacturers of the country to place before them specimens of iron plates which they considered best adapted for the purposes required. Plates, varying in thickness from ½ inch to 10 inches were sent in. The Committee found, on making experiments, that the steely description of metal, that was to say, metal which had been hardened, and went by the names of semi-steel, homogenous iron, &c. up to a thickness of ⅝in. possessed great resisting powers, but after that thickness, this description of metal

was not so well qualified to resist a blow of a projectile as wrought iron of the best kind. This having been ascertained, another law had been pointed out to them which they were not yet in a position fully to recognise. It was that the resistance of the plating increased with the square of its thickness. Thus if the resistance of a plate one inch in thickness was equal to one, the resistance of a plate two inches in thickness would be four; four inches in thickness 16; and six inches in thickness, 36. Considerable difficulty was felt in fastening the plates upon the sides of the vessels, as it was felt that all holes bored in them were a source of weakness. Mr. Scott Russell had a plan of fastening the plates, which, perhaps, he would explain to the meeting. Their great fear was not of a solid missile being driven through the ships' sides, but of the possible materials the shot might contain.—(Hear, hear.) They could scarcely hope effectually to exclude cold shot, but they did think it was possible so to construct a ship and so to plate it, that a hollow missile impinging upon its sides would be broken to pieces, and consequently they hoped to be able to exclude all shells, red hot shot, and shot filled with liquid iron, which were amongst the most terrible weapons of modern warfare. In the course of their experiments they had tried the effect of the shells upon an old brig, the Hussar. At the twelfth round the brig was on fire beyond the possibility of extinction. He thought it a misfortune that the stem and stern of the Warrior were not better protected—(hear, hear)—and the steering apparatus was placed in that part of the ship from which the missiles were scarcely excluded at all. He thought it a wise determination on the part of the Admiralty to convert the wooden line-of-battle ships laid down into armour-plated vessels of great size and speed. In the course of the Shoeburyness experiments they had found that at whatever angle the targets were placed the fracture made by the Armstrong gun was just as large, though it differed somewhat in shape, according to the angle. He could only account for this fact by supposing that the damage was done by the instantaneous concussion, and not by the shot boring or punching a hole through.

Sir WILLIAM ARMSTRONG said that, with regard to the prospective size to be obtained in the construction of artillery, he must confess he did not go so far as Captain Blakely.—(A laugh.) It was quite true that he himself was engaged in the construction of a 300lb gun—(hear, hear)—and the experiment was already very considerably advanced, and so far with perfect success — (applause); — but at the same time he must say he found the construction of even a 300lb gun on his principle a work of considerable difficulty, and he really would venture to suggest to Captain Blakely that it would be better to obtain a one-hundred pounder or a two-hundred pounder before he ventured upon such a monster as he had mentioned.—("Hear, hear," and laughter.) He agreed with Captain Blakely that the hooping of a cast-iron gun with wrought iron gave it great resisting power; but he differed from Captain Blakely in thinking that such mathematical nicety was required in the construction. Provided only care were taken to allow sufficient shrinkage, the hoops would adapt themselves to that amount of tension which would give the maximum resisting force of the gun, and before the hoops would give way the gun would have passed through the phase of greatest resistance. He entirely agreed with Mr Fairbairn as to the desirability of adopting the form of structure for plated ships which should obviate the use of wood.—(Hear, hear.) He attached great importance to this plan, because by adopting it much unnecessary wood would be got rid of, and the iron plates could therefore be thickened, but chiefly because by this means the liability of part of the ship rotting, and their having to pull it to pieces periodically to set it to rights again, was done away with.—(Hear, hear.) His opinions on the subject of iron-plated ships had been so often made known, that it would be mere repetition for him to go over the ground again. The only new point he had to bring before them was that in the construction of those ships they must chiefly keep in view their adaptation for a small number of monster guns. There had been a feeling among naval men that guns above a certain weight—five tons, he believed—could not be practically managed on board ship. Lately, however, their ideas had been considerably enlarged, and they now went as far as 7½ tons, which would be about equal to one of his two-hundred pounders. He believed that guns of a much larger size could be managed, but to do so of course they would have to avail themselves of machinery.—(Hear, hear.) Mr. Aston had explained the Whitworth projectile and had called attention to what he considered its various merits. He had also alluded to his (Sir Wm. Armstrong's) which now lay on the table before them. Upon this subject let them talk as long as they liked, Mr. Aston and himself would never come to an agreement.—(Laughter.) He believed that his own projectile would inflict a greater amount of damage than the other.—(Hear, hear.) Now this was the proof of the pudding:—Let a target be erected representing an object such as would be used in actual war, and then let experiments be made to see which missile would inflict the largest amount of injury. He had no doubt whatever that for punching a hole in iron plating the flat headed bolt invented by Mr. Whitworth was the form, if made of steel. But he apprehended that the object to be attained was not only to punch a hole in the side of an armour-plated ship, but to inflict so much damage as to disable her. What he wanted to effect was to be able to hurl a large mass, no matter of what form, against the vessel, so as to crush in her side, and he believed that this could be done by the use of guns of a large size. In the Whitworth projectile, the rotary motion was given by the shape of the bolt. In his own ordnance, the projectile was covered with a soft material, and so took the direction of the grooves. There might be advantage in both plans, but he did claim for his own this superiority, that there was less necessity for precision in the manufacture, and little fear of injury to the bolt. He had lately been making experiments with a large kind of projectile, one of which he had before him [A huge mass of metal, weighing some cwt.] In this projectile, instead of having a soft metal all round it, it was confined to three ribs, which would take the impression of the grooves. It was designed for a gun called the "shunt gun," the construction of which, not having a diagram with him, he could not explain.

Mr. SCOTT RUSSELL said there were one or two general considerations of this subject which he thought, if laid before the meeting, would save a good deal of misapprehension. If they would just set out by believing that we should never get perfect impenetrability, many schemes, with the answers to them, would be put out of the way. The whole practical part was incorporated in one expression of a great sailor, "Whatever you do, for God's sake keep out the shells." Having been in vessels fired at, and having been behind iron targets fired at, he was in a position to say that he could stand behind iron plating with a wonderful degree of comfort.—(Laughter.) You were sure the shells would be kept out, and if two or three holes were punched in the side of the ship by the large shot neither you nor the vessel were much the worse for it.—(Laughter.) But if Sir William Armstrong should be able to do as he had just said, to bring large masses to bear upon the sides of these iron-plated ships then this was another mode of destruction quite as injurious as destruction by shells would be. The whole question then resolved itself into these two things:—Keep out the shells, and prevent Sir William Armstrong driving in the sides. The shipbuilding question at the present time involved the very difficult problem how to build a ship with an enormous weight in the place where good shipbuilders generally contrived to keep out all weight. The last vessels were loaded with 1,000 tons, the new vessels would have 1,500 tons, and this weight was not only a great inconvenience, but a great injury to the sides of the ship. He thought he might fairly say

that in the construction of these large ships the builders could afford to allow of 9in. of iron to be used partly in armour, and partly in the construction of the ship. The question they now asked the Iron-plate Committee, and which he believed Mr. Fairbairn's experiments would settle in a very short and decisive manner, was how much of this iron could be used in the construction of the ship, and how much must be used in armour-plating outside. Take it that there was eight inches of plating allowed. If the Committee would be content with a 2-inch plate—and a 1-inch plate on the outside leaving the builders five inches to be welded into the sides of the ship, he was prepared to say that this would be an enormous advantage. He would even meet them further, and give them four inches to be used for the armour, leaving him four inches to be used in the construction of the ship. But the Committee would insist upon having a 5-inch plate to go to the bad, leaving him only three inches for the ship. There was another point upon which the builders were at issue with the Committee. The Committee say they will not have holes in these iron plates, and the builders reply that, so far as they knew at present, the Committee must have holes. Sir J. D. Hay had asked him to lay before the section a plan which he had submitted to the Admiralty as long ago as 1854. He would bring up between the plates a piece of extremely soft malleable iron. This he would beat in its place after the plates were on, so as to make a round-headed tines riveted all the way round. This plan, if successful, would obviate the necessity of perforating the plates; but allow him to say that he did not believe in his own opinion until tried, for there was scarcely a theory promulgated but was knocked down by those horrid Armstrong and Whitworth guns—(laughter) and at the present moment he had not a single theory to set up. The Warrior had been built without armour on her extreme ends, and he (Mr. Scott Russell) had some of the blame or the merit of that arrangement—which it was, remained to be seen. But yet he would take very little credit on that point; for this reason, that when the dimensions and the required speed of a vessel were settled the question as to whether she should bear armour from end to end was determined beforehand. Referring to Mr. Aston's paper, Mr. Russell entered into calculations to show why he did not attach much importance to the beautifully exact form of the Whitworth projectile. He believed that in proportion as the velocity of the projectile was less than the velocity of sound, 1,100 feet per second, in that proportion only might some advantage be derived from distinction of shape. But this was one of the subjects upon which no wise man would dogmatise, but would be grateful to anyone who would institute experiments.—(Hear.)

Admiral Sir E. Belcher considered that the suggestion of Dr. Eddy, for constructing small vessels to compete with the iron-cased frigates, had been met by Mr. Scott Russell's observations on the incompatibility of weight and speed without dimensions. The height of the large vessel would enable her so to depress her guns that the smaller boat would present an angle of about 60 deg. instead of the angle stated. The curved deck of the proposed gunboat involved the necessity of its being rendered bomb proof, and that entailed iron plating, equal to the plating of a frigate. The fibre suggested for the packing would be peculiarly liable to smoulder or to burn, and the salt with which it was proposed to render it incombustible would corrode the iron so rapidly that, in the course of a few months, the vessel would be useless. It had occurred to him that instead of the iron plates being packed up with wood, iron ribs placed transversely, something in the gridiron fashion, at intervals from each other less than the diameter of the shot, and the interstices filled up with wooden material, would be a better mode of resistance. By the present system of laying the iron plates, if one were injured when the vessel was abroad, it would be impossible to replace it, perhaps for months or even years. Therefore he thought it would have been better if Mr. Scott Russell had followed out his plan of sliding the plates in from the water line upwards, because if one of the lower plates happened to get injured, it could be removed, and the other plates could be slid down to fill up the vacant space, and a new plate could be put in at the top without difficulty. After the battle of Algiers, it was his duty to clean out the captain's cabin. He was surprised to find that a ream of foolscap, which had been struck by a large shot had simply been crimped up. In 1854, he applied for leave to build a battery of compressed brown paper, and he believed that this material, which was one of the most powerful repellants of shot, might be advantageously used. Sir E. Belcher alluded to the force with which even wooden ships could charge and split icebergs, and expressed his decided opinion, that if the weight of the Warrior struck the Gloire across the bows the latter must inevitably go down. He himself, if hard put to it, should have no objection to have a try at La Gloire in one of the old wooden ships—(laughter)—and he thought he saw some of his naval friends around him who would say the same. He complained that the peculiar construction of the new vessels would deprive them of the pleasure of running down an enemy, which was a point upon which naval men prided themselves.—(Laughter and applause.)

The Rev. Dr. Robinson (Armagh), said the paper which had been read by Mr. Reed could hardly be rated too highly, and he hoped a recommendation would proceed from that section that it should be printed. In the course of an interesting address, Dr. Robinson traced the invention of armour plates to Lord Rosse, and whilst paying a high tribute to the splendid mechanical genius of Mr. Whitworth, he pointed out that both the elongated projectile and the beautiful system of polygonal rifling were inventions dating much further back than his time. He himself had seen a rifle on the polygonal principle made two centuries before Mr. Whitworth was born.

Mr. Fairbairn, in allusion to the remarks of Mr. Scott Russell as to the possibility of using a number of single inch plates instead of one solid plate, stated that the experiments had shown that one two-inch plate was equal to three or four one-inch laminated plates. He quite agreed with Sir E. Belcher as to the form of the bows of the Warrior. His own opinion was that they should have been curved instead of projecting.

The discussion then terminated, and the section adjourned, shortly after four o'clock.

TELEGRAPH SOIREE,

AT THE FREE-TRADE HALL.

In the evening, a soirée was held at the Free-trade Hall, and attracted a numerous and brilliant gathering. The subject specially selected for the evening's entertainment was that of telegraphic communication, and elaborate preparations had been made for rendering the meeting entertaining and instructive. A large collection of apparatus was placed in the room, upon which various experiments were tried to illustrate the principles upon which they are worked. The Electric and International Telegraph Company had a large display, including two single-needle instruments, one in connection with Derby and the second with Birmingham; a double-needle instrument, in connection with Liverpool; a Bain's printing instrument, in connection with Bristol, Cardiff, and Falmouth; a Morse's embossing instrument, communicated with Dublin; a second with Glasgow, Edinburgh, Aberdeen, and Balmoral; a third with London, the Hague, Amsterdam, Hamburg, Berlin, St. Petersburg, Moscow, Odessa, and Nicolaev. The Magnetic Telegraph Company showed Brights' acoustical telegraph, an instrument which is the joint patent of Sir Charles Bright and Mr. Edward Bright; and Highton's single-needle telegraph. Professor Wheatstone's various patents, and Mr. J. W. Brett's electric type printing telegraph attracted much attention. By this latter instrument the first submarine telegraph message was transmitted and printed in Roman type across the channel from Dover to Calais. The other exhibitors of telegraphic

instruments were Mr. T. Allan, and Mr. W. T. Henley. Other electrical machines of various ingenious purposes were shown by Messrs. Siemens, and Halsk and Co. Mr. H. Wilde, M. Sartais, and M. Breguet. Specimens of submarine cables and modes of insulation were shown by the Gutta Percha Company. Mr. J. W. Brett, Messrs. Hall and Wells, Messrs. Newall and Co. Messrs. Silver and Co. Mr. W. H. Preece; the Electric and Magnetic Companies, Mr. O. Rowland, Dr. J. Shaw, Herr Faber, Professor W. Thomson, and Mr. Fleeming Jenkin, Messrs. Elliott Brothers, Mr. Culley. Professors Abel and Wheatstone showed an apparatus for exploding mines by means of magneto-electricity. The message sent by the President of America through the Atlantic cable, was lent for the occasion by the Atlantic Telegraph Company; and Dr. Cattell, Mr. Dodwell, Messrs. Bright and Clark, and Messrs. Reid Brothers, sent illustrations of subjects connected with telegraphy. It had been previously arranged that a short lecture explanatory of the system of telegraphing by electricity should be delivered by Mr. Grove; and shortly after eight o'clock the President of the Association, W. Fairbairn, Esq. introduced Mr. Grove to the meeting.—Mr. GROVE said that some three or four days ago he was requested by the authorities of the British Association to give a short impromptu introduction on the electric telegraph; but it was not until after it was too late to recede that he found instead of having to explain a few instruments to a select company he had to address the whole body of the British Association. They might probably have heard of Madame d'Estrange and the German philosopher who wrote philosophy as Germans only could write. Having got him comfortably seated, she said to him, "*Ayez la bonté de me donner l'histoire de tout le monde.*"—(Laughter.) He was expected to do something similar, for he had to explain 70 or 80 instruments of the greatest complexity within the limited space of half an hour. After a few remarks on the early history of telegraphy, Mr. Grove alluded to the subsequent progress of the science, and the vast number of other applications of electricity and magnetism. Laplace's improvements, and the facility given for the ascertaining of correct information as to the transmission of electricity, by the use of two wires—the current being deflected from the further end to the transmitter—might be said to be the starting point of electricity as now used. The use of dials, with magnets corresponding with the number of letters in the alphabet, and fifty wires; and the superseding of this system by the discoveries of Messrs. Cooke and Wheatstone about the year 1836, which rendered necessary only ten wires and five magnets—several letters being placed at intersectional points of each magnet—were ably explained. The number of wires was soon reduced to one, and there was a difference at the present d y as to whether one or two was the best number. Instead of having letters to point to, the words were now indicated by symbols—one tap of the magnet on one side signfies A, on the other B; two taps in one direction C, and so on, by thus "ringing the changes,"—by two or three deflections on each side sufficient power was obtained to communicate anything which was desired. This was the recognised mode of communication to the present day. It was desirable, however, that persons comparatively unskilled should be able to communicate by telegraph and that greater certainty should be obtained in the indicating of the various letters. They had now before them on the tables several modes of effecting that, which, he thought, was now satisfactorily performed by the dial telegraph. The merchant in Manchester, who wished to communicate between his country house and his counting house might now do so without learning his alphabet beforehand or having practical experience in telegraphic correspondence. This dial telegraph was worked by electro magnetism. The next step was the introduction of magneto-electricity, the difference between which and the pre-existent modes of telegraphy was described. By means of the printing telegraph, the same impulse which conveyed the signal imprinted it upon paper or some other material, leaving a document incapable of forgery—at once communicating and recalling that which was communicated to the place from which it was sent. Another kind of printing telegraph was that in which a band, passing between two points, received black marks from a chemical substance, which became discomposed by the passage of the electric current. One of the most recent applications of the printing telegraph was that in which a revolving roller was placed near the battery, and by the use of an electric magnet and raised index a length of paper upon the roller received the impress of the printing ink in dots and lines which were easily understood. Specimens of those four divisions—the electro-magnetic, the magneto electric, the letter-printing, and the symbol printing telegraphs—were before them, as well as specimens illustrative of the progress of submarine telegraphy. The lecturer then commented on the system of automatic relays, whereby communication could be had to almost unassignable distances, and explained the means by which Wheatstone calculated that electricity travelled at the rate of upwards of 200,000 miles per second—equal to going round the earth eight times in a second. Mr. Grove remarked that it was to Professor Clifton and Messrs. Dodwell and Newman, of the two great Telegraph Companies, that they were indebted for the pains and labour, skill and anxiety, which had got together and arranged the mass of complex instruments, &c. which they were to see that evening. They were in communication with a large number of establishments in Manchester, and also with Liverpool, Bristol, Dublin, Glasgow, Balmoral, Paris, Brussels, Berlin, St. Petersburg, &c. Mr. Grove then fired, by means of a battery on the platform, a number of fusees fixed at the extreme end of the hall. During the latter part of the lecture and subsequently a number of messages were received and despatched with marvellous rapidity, Professors Clifton and Roscoe and Messrs. Dodwell and Newman giving their assistance.

In the course of the evening the Prince Consort sent a message from Balmoral to the President, which was read to the audience. The message and reply were as follow:

8 32 P.M.—Prince Consort, Balmoral, to the President of the British Association meeting, Manchester. Is the meeting of the British Association successful?

REPLY.—8 45 P.M.—The President of the British Association, Free-trade Hall, Manchester, to H.R.H. the Prince Consort, at Balmoral. Your Royal Highness will be pleased to hear that the meeting is a great success. Upwards of 3,000 members and associates.

As the Electric and International Telegraph Company offered to the persons present gratuitous correspondence with any friends at those towns with which they were in communication, we need hardly say that many ladies and gentlemen availed themselves of the opportunity to address inquiries and congratulations to their distant relatives, &c. of which we offer a few examples:—

TO ABERDEEN.—9 20 P.M.—I cannot answer your letter this week, but will write early next week. How are you?

REPLY.—9 50 P.M.—Mag. is at tea with the P——s. All well. She can't answer herself. She will write soon.

TO EDINBURGH.—9 27 P.M.—Will be glad to know how his father and the family are.

REPLY.—9 55 P.M.—Father and family well and hearty. Expect to see you soon.

Mr. Fischer, of the Company's "Foreign Office," superintended the continental messages. His proficiency as a linguist very much facilitated the transmission, by addressing the respective clerks in their own language.

At 8 p.m. messages were exchanged with the Hague; at 8 10 p.m. with Hamburg; at 8 20 p.m. with Berlin.

At 8 51 p.m. the following inquiry was made of St. Petersburg:—What is the time; and how is the weather?

REPLY.—8 52 P.M.—Weather beautiful; sky clear; time, 10 52; temperature, 12½ deg. Reaumur.

8 55 P.M.—Please give degrees in Fahrenheit?

REPLY.—8 57 P.M.—I have given it in Reaumur, and leave it with you to state it in Fahrenheit.

At 9 5 p.m. St. Petersburg joined up the Manchester

and Moscow lines, when Manchester put the following question to Moscow:—

9 6 p.m.: Please say what weather you have, and also your time?

Reply.—9 7 p.m.—It is raining; it is 36 minutes past eleven.

At 9 17 p.m. Moscow joined up the Manchester and Odessa lines, when the following correspondence ensued:

9 17 p.m.—Odessa here.

9 18 p.m.—Manchester asks: What is your weather and time.

Reply.—9 20 p.m.—Weather cool but very clear; windy; six minutes past eleven.

9 21 p.m.—Is the harvest over?—[Here is a longer interval, the Odessa clerk having been called away from his instrument.]

Reply.—9 32 p.m.—The harvest is over, and the grapes are now in season.

Odessa then joined up the Manchester and Nicolaief lines, when the two clerks exchanged the usual compliments; but the occurrence of a violent storm in some locality through which the wire passed, and the currents of atmospheric electricity which it imparted to the wire, led to the abandonment of the intention to extend the circuit to Taganrog on the north-east coast of the sea of Azoff, which would have been about 3,100 miles distant. However, the communication with Nicolaief direct *via* Berlin, St. Petersburg, Moscow, and Odessa, is a fact which we believe to be unsurpassed in the annals of telegraphy. The last most distant station spoken to by the Electric and International Telegraph Company was Odessa, by a much more direct route a distance of about 2,200 miles, whereas the distance by way of St. Petersburg and Moscow to Nicolaief is more than 2,800 miles.

At the conclusion of the lecture, the President remarked that the audience would join with him in heartily giving a vote of thanks to the lecturer, and also to Professor Clifton for the excellent arrangements which had been made for the purposes of the evening.—(Loud applause.)

The company did not separate until nearly eleven o'clock.

MONDAY, SEP. 9.

The meetings of the sections were continued to-day.

MEETING OF THE GENERAL COMMITTEE.

The General Committee met to-day in the Mayor's Parlour, Town Hall, WILLIAM FAIRBAIRN, Esq. LL.D. F.R.S. president, in the chair.

The minutes of the meeting on Wednesday last were confirmed; and the name of Colonel Sykes, accidentally omitted from the list of the Committee of Recommendations, was ordered to be added.

THE NEXT PLACE OF MEETING.

The CHAIRMAN said that the meeting was specially called to decide the place of meeting for next year; and he was now ready to hear any gentlemen deputed from Cambridge, Newcastle-upon-Tyne, Birmingham, Bath, and Nottingham.—Professor PHILLIPS read the formal documents from each place. They were as follow:—Cambridge: An invitation given two years ago by the members of the Senate, and now resumed; from the Philosophical Society; and from the municipal authorities. Newcastle: A document showing that accommodation could be afforded for the meeting of 15,300 persons—information which, Professor Phillips said, it was always advisable to have. Birmingham: From the Town Council, and various other public authorities it being stated that a deputation had attended at Aberdeen and again at Oxford.—Bath: From the Town Council, and the Somersetshire Archæological and Natural History Society: for the meeting of 1863, or as soon after as possible.—From Nottingham: From the Council, and other bodies; also for 1863, or as early as possible.

Professor SEDGWICK supported the invitation from Cambridge.

Mr. Alderman BELL spoke on behalf of the Corporation of Newcastle.

Mr. A. RYLAND, mayor of Birmingham, supported the invitation from the Town Council of that borough.

Mr. TITE, M.P. for Bath, urged as one of the great claims on behalf of that place, the fact that it had never yet been visited by the Association.

The Rev. Dr. ROBINSON moved that the next meeting be held at Cambridge. After this Manchester meeting, during which the men of theory—speaking from his own experience—had been greatly benefited and enlightened, it would be only fair that the men of practice should return the compliment by visiting Cambridge, and so receive some little of the scientific inspiration there to be met with.—Mr. M. CURTIS (mayor of Manchester) seconded the motion; and it was unanimously agreed to.

Professor SEDGWICK moved that the Rev. Professor Willis be requested to accept the presidency next year; than whom, he was sure, a fitter man could not be found amongst living philosophers.—Professor BABINGTON seconded the motion; and it was unanimously adopted.—Vice presidents for the year were appointed, as well as the local secretaries and treasurer.—The Rev. Mr. Hopkins was re-elected general secretary; Mr. John Philips, assistant secretary; and Mr. John Taylor, general treasurer. The members of the Council for the year, and the auditors, were also appointed; and the Committee then adjourned.

PROFESSOR AIRY'S LECTURE ON THE GREAT SOLAR ECLIPSE.

Last evening, Professor AIRY, astronomer royal, delivered a lecture at the Free-trade Hall, on the great solar eclipse of 1860. The body of the hall, the promenade where the models, &c. were placed, and the galleries, were crowded in every part. In the front of the platform was placed a gigantic wooden orrery on a revolving pivot, and to this the lecturer frequently referred in illustration of his discourse. At the back were hung a large number of drawings of every phase of the eclipse, possible and impossible, the latter, in the lecturer's estimate, rather predominating. Under the management of Dr. Tyndall, of London, apparatus had been arranged in the gallery opposite the entrance door, so as to impress the electric light into the service of the lecturer; and in illustrating the polarisation of light this was used to admirable purpose. Shortly after the commencement of the proceedings, an unfortunate interruption occurred. A portion of the hall had been railed off, and set apart for reserved seats, for admission to which white tickets were required. There was a good deal of unoccupied room in front of the reserved seats, whilst every other part was crowded; and this arrangement consequently gave considerable dissatisfaction, which was rather loudly expressed. Ultimately, in spite of the efforts of Captain Palin, chief constable, Mr. Superintendent Maybury, and other officers, the bar was broken down, and the passage forcibly carried, amidst some applause. A virtue was then made of necessity, and chairs were brought and placed in the unoccupied space. The proceedings afterwards were marked by the utmost order and decorum.

Dr. FAIRBAIRN, the President of the Association, ascended the platform, and said he had the greatest pleasure in calling the attention of the meeting to the Astronomer Royal's discourse upon the eclipse of the sun in Algoa Bay. He had no doubt that with a little patience and careful attention exercised on the part of the audience, they would find their time most pleasantly occupied by the Astronomer Royal. He was sorry for what had just taken place, and he hoped that further interruption would not occur.—(Applause.)

Professor AIRY, who was warmly received, said that when the authorities of the British Association intimated to him their wish that he should give some statement relative to the eclipse of the 18th July, 1861, it became obvious on the slightest consideration that it would not do for him to confine his remarks to that year. There had been three remarkable eclipses in Europe—one in 1842, one in 1851, and one in 1861; and besides these there had been some other eclipses in 1850 and 1858 of which observations had been made. With the year 1842 commenced a new epoch in the science of eclipse, and it was absolutely necessary for him, if he wanted to make anything clear with regard to the eclipse of 1860, to go back to 1842, and also to give a few notices relative to eclipses generally. He proposed, therefore, to commence with a few remarks upon eclipses generally, and he should then state certain observations made in the year 1842 for the first time and continued up to the present time, and should endeavour to point out the deduction which he thought might legitimately be inferred from them. When first mankind began to observe total eclipses there was no great difficulty in conceiving that eclipses of the sun were caused by the interposition of the moon, but in a very short time it became obvious that this interposition which prevented the light from coming to us was not the interposition of a body at the same distance as the luminous body, but that the circumstances of an eclipse must depend upon other circumstances—namely, the distance of the moon as related to the distance of the sun, and the direction in which the

moon was seen as related to the direction in which the sun was seen by means of the orrery. Professor Airy rendered this plainer by explaining the relative motions of the earth, sun, and moon, and showing the reasons why some eclipses were merely partial and other annular. There was a recurrence, he said, in eclipses of a very singular nature, which had been known from the most distant period of time, that was at the end of 223 lunations, which would occupy 18 years 15 days and 8 hours. When this period had elapsed, there was an eclipse in all its important circumstances similar to the first eclipse, but in consequence of the time required being 8 hours, as well as 18 years 15 days, the same side of the earth would not be presented to the eclipse. This point was worthy of their attention, because of its connection with the two eclipses of 1842 and 1860. There was an appearance which had been observed in various places, and which he should mention now, not because he had any respect for the accounts of it, but because it had been often referred to. It was known as "Baily's beads." As the totality approached, an appearance was observed resembling bright points interrupted by black spaces. He had looked for this appearance several times, but had never seen it. Probably that was because he looked carefully and with good telescopes—(laughter),—and that he believed they had never been seen except through bad telescopes. His friend, the late Dr. Baily, first observed them. He believed Dr. Baily must have had the misfortune to look through a bad telescope.—(Laughter.) In the year 1842 it was known that there was a total eclipse going on, but people generally did not understand what was to be seen, so little attention, comparatively, was attracted to it. Two persons only went from England to see it, of whom he (Professor Airy) was one. Well, they saw a total eclipse in its grandeur, and he might say in its horror. Nobody who had not seen a total eclipse could conceive what it was. No eclipse approaching to totality gave any idea of what an eclipse was when it was total. There were appearances about the eclipse of 1842 for which some of them were not prepared; but when their telescopes were turned upon the moon there were appearances for which none of them were prepared. Red flames were seen shooting apparently out of the moon. What could they be? The astronomers could make nothing of them, partly because they were not prepared to make observations on this point. One observer disturbed astronomers for some time by declaring that he had seen the flames upon the moon; but on investigation it was found that he had seen them through an opera glass magnifying four times.—(Laughter.) After a discussion, and various opinions, the astronomers came at last to this conclusion—that there were four flames projecting apparently from the moon. Similar appearances were found to have been mentioned twice before. They were noticed as red clouds in the observations of Captain Stanyon; and in the "Philosophical Transactions;" by a Swede, who observed the eclipse of 1833, and described certain appearances in such a manner as to leave it doubtful whether they were flames or clouds. This was left in doubt until 1851, when a number of astronomers went from England to witness the eclipse of that year. On this subject he should make some remarks which would apply to the eclipse of 1860. Professor Airy exhibited three drawings made by himself of three different periods of totality in the eclipse of 1851, in each of which red flames were conspicuous. He described how these appearances diminished gradually on one side and increased in size on the other, and said that this first gave the notion that they were attached to the sun, because, had they belonged to the moon, they would have gone with it from one side to the other without change. But there were so many discrepancies in the different drawings made of these flames as almost entirely to upset all opinions about them. One observer, however, in Russian Poland, in whom he had the greatest confidence, saw them as he (Professor Airy) saw them, and mentioned an additional test which tended to show that they belonged to the sun. Professor Airy alluded to the theory that these flames were due to what was termed the "interference of light," and explained why in his opinion this could not be. After 1851 there was the eclipse of 1858, which passed across Brazil, and was observed by some of the Brazilian authorities, and also by the French, who, let it be said, were never behindhand when any scientific subject had to be investigated. This eclipse was not seen from a very favourable situation, but it was very well observed, and one of the most careful of these observers had distinctly remarked that the red flames disappeared on the one side, and re-appeared unchanged on the other side—thus confirming his (Professor Airy's) observations. He would now come to the eclipse of 1860. That eclipse began on the western coast of America, at sunrise; it passed through South America to the south of Britain, thence to Spain, and through Algeria to the Red Sea; where it terminated at sunset. Preparations were made to observe this great eclipse by different persons and bodies. The French government sent to the central part of Spain, and also took care there were persons in Algeria. The British officers on the west coast of America observed it. In Spain the observations were put into his hands, as Astronomer Royal. This country differed from France in having no paid body of Academicians; but then we had, he was proud to say, a large number of amateur astronomers, and it appeared to him that it would be best to recommend to the Government to grant a vessel for the purpose of conveying a party of amateurs to Spain. The Admiralty took up this question with great kindness, and placed the finest vessel in the navy, the Himalaya, at the disposal of the expedition; and not only were the astronomers carried to Spain, but they were well provided for on the journey in every respect. In the arrangements, which were to some extent entrusted to him, the principal condition was that every person should go out with an adequate instrument and with a definite purpose. On the whole this arrangement was well carried out. There were some failures, but there was a great deal well done. It was principally from the observations of this party that he should extract the statement he had to lay before them. They were much indebted to Mr. Vignoles, who, as well as the Directors of the railway for which he was then the engineer in Spain, rendered them every assistance, and the authorities of another line being constructed by British engineers also showed them every hospitality. Without this they would scarcely have been able to get over the country. The Astronomer Royal proceeded to describe, by the aid of diagrams, the appearance of the corona, with respect to which he remarked that the accounts he received were a mass of discordance. He particularly alluded to the appearance of the planets Venus and Jupiter, which shone out near the sun as if there had been no sun in the hemisphere. Mr. Plantamour, of Geneva, who went to a place on the eastern coast of Spain, took three drawings—at the beginning, the end, and the middle of totality. What he depicted seemed to show that the appearances were produced by something like a cloud, or a cloudy atmosphere between the earth and the moon. It could not be from anything in our atmosphere. Was there an atmosphere extending from the earth to the moon? He (Professor Airy) declared that he knew not; but he knew nothing else that would account for what Mr. Plantamour depicted. The whole train of observations on the corona led him (Professor Airy) to believe that there was some reflecting medium extending almost, if not quite, from the earth to the moon. He did not know whether that was incompatible with what was known of the inter-planetary atmosphere; but there was nothing else that supported these appearances, and this theory did so in some measure. It was also supported by the observation of polarisation. When light was not reflected, it was only the common vulgar light; but when reflected from the surface of a transparent medium, it received the modification of

polarisation. So, when that modification was discovered, it was inferred, with great probability, that the light had been reflected. If we did that we should be going a long way towards showing that the light in this case was produced by something like an atmosphere intermediate between the earth and moon. The learned Professor showed, by an experiment, that two images of light, in the ordinary state, could be made to revolve round each other without alteration in intensity; but that when reflected from unsilvered glass, the lights disappeared alternately while revolving; and that the same effect resulted when the rays were coloured. Some of the Himalaya party were prepared specially to observe whether the light from the corona or other parts was polarised. The result was this:—Some of the English observers were abundantly satisfied that the light of the corona was polarised; but they could not decide whether or not the polarisation was of a character that implied reflection in the plane passing lengthwise of the rays; but one of the foreign observers who went to the east of Spain saw that it was so polarised. This was in every way consentaneous to the idea that the light of the sun was deflected in some way to form the corona. If that was so, he (Professor Airy) knew of no explanation but that there was something like an atmosphere extending to the moon, or possibly further. The red prominences were seen in great beauty during this eclipse. The question had been raised, whether they belonged to the sun, the moon, or something intermediate. By means of a model, Professor Airy showed that if the prominences belonged to the moon, they would follow her; but if they belonged to the sun, they would be shortened on one side and lengthened on the other, during the passage. *Prima facie*, this was a strong argument that they were parts of the sun. But Mr. Fahey pointed out this:—Supposing a prominence at the top of the sun. When totality was just beginning, it would be to the left of the moon's centre; it would be over the centre as the eclipse advanced; and would pass on to the right of the moon's centre as the eclipse advanced. It was impossible that these fantastic appearances could be represented in the same manner, by all parts of the moon's limb. Mr. Warren de la Rue, who was skilful in eye-drawings, made two at different stages of the totality. Mr. Bruhn, of Leipsic, who went to the east of Spain, determined to observe particularly the brilliant cusps of the sun; and he recorded that the red prominences appeared before the sun had disappeared. He compared the position of one of the prominences with that of the bright cusp. The place of the cusp at a particular moment could be calculated with the greatest accuracy. He found that if the cusp belonged to the moon, it must have shifted 26 deg. on the moon's limb; but that if it belonged to the sun, it had not shifted 1 deg. during the time he was observing. This was almost irresistible evidence that the red prominences were attached to the sun. In 1851, Mr. Busch, of Konigsberg, took a daguerreotype of the moon and the prominences during the eclipse; but it was not a very successful attempt. Mr. De la Rue and others thought of the exceeding desirability of getting photographs last year. Amongst them was Father Secchi, of the Palazzo Romano, who obtained five small photographs, while Mr. de la Rue got two large ones. Of the five, through the kindness of Mr. Aguilar, he had obtained photographic copies. He had made measurements from them with the spots as given by Mr. De la Rue from his eye observations, and he had obtained positive proof that these prominences were connected with the sun. Some British officers stationed on the Western Coast of America observed the totality from Puget Sound when the sun was only two degrees above the horizon; and he had received some admirable drawings by Captain Richard, R.N. and Captain Parsons, R.E. He thus had drawings of the red prominences as they appeared at Vancouver's Island and on the Eastern side of Spain—just the extreme limits of the zone of observation. Were the prominences seen the same in the two cases? He could not say that they were, although he had tried to reconcile them. But was it likely that there should be a change? The total obscuration at Vancouver's Island was two hours earlier than at the eastern side of Spain; and if the sun was constantly boiling up, and these protuberances were from fumes, there was nothing to wonder at if there was a change during that time. All he knew was that there was no sensible change while the eclipse was passing over Spain. If attached to the sun, could we see these red prominences at other times than during an eclipse? And if not, why not? He had tried all he could to do so, with apparatus of which Mr. James Nasmyth contributed a most important point; but he had never succeeded. He lent the apparatus to Mr. Piozzi Smith, when he went to the Peak of Teneriffe; but that gentleman failed to see the protuberances. But that did not at all detract from the evidence of their attachment to the sun; for we never could cut off completely the highly-illuminated atmosphere through which we look at the sun and all about him. Cut off all we could, there would still be a blaze of light that would extinguish anything even much brighter than these prominences. Professor Airy explained the admirable mode of mounting the Kew photo-heliograph adopted by Mr. De la Rue; and he advised everybody who pretended to "observe" to have a telescope equatorially mounted and driven by clockwork. In the photographs taken prominences were brought out of a class different from those seen by the eye. In fact the photographs brought out more than could be observed by the eye; and great care was necessary in comparing the two sets of results. The learned Professor concluded his address (which lasted an hour and three-quarters) by thanking the audience for the patience with which they had listened to him.

Mr. De la Rue then threw upon a screen the two photographs taken by himself of the eclipse; and the beauty of their effect called forth loud applause. He also exhibited some views prepared to show the prominences as witnessed by Mr. Prichard and others.

The President (William Fairbairn, Esq.) called upon the audience to acknowledge, by acclamation, their thanks for the deeply interesting lecture delivered by the Astronomer Royal; an appeal which was heartily responded to.—In responding, Professor Airy said it had rarely or never occurred that observations on an eclipse could be brought together from so large a range of country. Indeed, he believed that information on such an event had never been so largely given to anyone before as to him on this occasion. That information could not have been repeated to a better audience than the present; and he was very much gratified if they had been interested.—(Applause.)

Mr. Hopkins, of the Temple Church, London, afterwards performed a selection on the great organ, and a considerable portion of the company remained to inspect portions of the several exhibitions.

PROCEEDINGS OF THE SECTIONS.

Section A.—MATHEMATICAL & PHYSICAL SCIENCE.

The section met at eleven o'clock, in the Friends' Meeting House; General Sabine occupying the chair at the opening of the proceedings.

The Chairman, before the commencement of the ordinary business, drew the attention of the section to a paper read by the Rev. Mr. Hincks, on Saturday, "On the quantity of the acceleration of the moon's mean motion, as indicated by the records of certain ancient eclipses." In the course of his paper, Mr. Hincks adverted to a difference of opinion between himself and the Astronomer Royal with regard to ancient eclipses. The Astronomer Royal being obliged to leave the section having another engagement, was not enabled to reply to Mr. Hincks, and he was now desirous of doing so.

The Astronomer Royal then came forward, and made a lengthened explanation of his views on ancient eclipses,

in the course of which he insisted upon the existence of the four solar eclipses disputed by Mr. Hincks.

Lord Wrottesley here took the chair, the President and General Sabine having another engagement.

Mr. Fleeming Jenkin read a paper "On permanent thermo-electric currents in circuits of one metal," which he illustrated by experiments.

BINOCULAR LUSTRE.

Sir David Brewster next read a paper "On binocular lustre." He commenced by stating that some years ago it was observed by Professor Dove that when the right and left eye figures of a pyramid, or other mathematical solid, the one drawn on a white, and other on a dark ground, were inserted in the stereoscope, the solid in relief appeared with a particular lustre. Professor Dove described the lustre as metallic, and in another place, where he described the diagrams as drawn with white lines on a black ground, and with black lines on a white ground, he stated that the pyramid in relief "appears lustrous as made of cyraphite." Other observers described the lustres differently, some as resembling ground glass, and others as like paper darkened with a black lead pencil, while Professor Wood regarded it as "recalling the idea of highly-polished glass." In order to explain this phenomena, Professor Dove remarked "that in every case where a surface appeared lustrous, there was always a transparent, or transparent-reflecting, stratum of much intensity, through which we see another body. It is therefore externally reflected light in combination with internally reflected or dispersed light, whose combined action produced the idea of lustre. This effect," he elsewhere added, "we see produced when many watch glasses are laid in a heap, or when a plate of transparent mica or talc, when heated red hot, is separated into multitudes of thin layers, each of which, of inconceivable thinness, is found to be highly transparent, while the entire plate assumes the lustre of a plate of silver." To these examples of lustre, produced by these plates, not in optical contact, or if in actual contact, having different reflective powers, were to be added the following: pearls, mother-of-pearl, pearl spar, and composite crystals of calcareous spar, and decomposed glass of all colours. The cause of these various kinds of lustre, and of that of metals, had always been well known, and when binocular lustre attracted the attention of philosophers, it was natural to ascribe it to the same cause. Professor Dove did this, and considered the dark surface in the one picture as the dispersed light, and the white surface as the regularly reflected light, the dark surface being seen through the white surface. This theory of binocular lustre, he had reason to believe, was not satisfactory. The phenomena was first observed by himself in 1843, under conditions of different forms than those under which it was subsequently seen in the stereoscope. Having adverted to a paper "On the knowledge of distance given by binocular vision," published by himself in 1844 in the "Edinburgh Transactions," he said that with his knowledge of the phenomena he could not adopt Professor Dove's explanation of the lustre seen in the stereoscope by the union of figures on dark and white, or differently-coloured surfaces. In order to test this explanation by other means, he combined faces that had no geometrical figures upon them, and he found that binocular lustre was not produced. This experiment seemed decisive of the question. He was led to infer from it that the lustre observed in the combination of right and left eye figures of solids, was not due to the rays from a dark surface passing through a lighter one to the eye, but to the effect of the eyes in combining the two stereoscopic figures, and to the dazzle occasioned by the alternating intensities of the two combined tints, the impression of one of the tints sometimes disappearing and re-appearing. He referred to an article published by Professor Road, of Troy, on his (Sir David Brewster's) "Theory of Lustre," and which he disavowed, not having adopted any "theory of lustre." He had merely started an objection to Professor Dove's theory of binocular lustre, and an opinion regarding its cause; and as the simple experiment on which he founded that opinion had been made by others with a different result, he thought it right to re-examine the subject with the assistance of other eyes than his own, and had obtained results which might be of use to those who were disposed to study the subject more elaborately. Binocular lustre was a species of lustre *sui generis*. It was a *physiological*, not a *physical* phenomenon, and had no relation whatever to those varieties of lustre which arose from the combination of lights reflected from the outer and inner services of luminated transparent, or translucent bodies. He assigned various causes for the physiological character of the phenomenon, and then added, "If binocular lustre arises from a physiological and not from a physical cause, we must look for this cause in the operations which take place in the eyes of the observer when binocular lustre is distinctly seen. These operations are of two kinds. First, in combining geometrical or other figures to represent solids whose parts are at different distances from the eye, the optic axes are in constant play, not only in varying the distance of their focus of conveyance, to unite similar points at different distances on the two diagrams, but in maintaining the unity of the picture by rapidly viewing every point of its surface. Secondly, when the two surfaces have different shades or colours, the retina of one eye is constantly losing and recovering the vision of one of them. Each optic nerve is conveying to the brain the sensations of a different tint or colour. The brain is therefore agitated sometimes with one of these sensations, and sometimes with the other, and sometimes with both of them combined, and it is therefore not an unreasonable conclusion that, in the dazzle produced by this struggle of flickering sensations, something like lustre may be produced. In studying the subject of lustre there are some facts deserving of attention. In a daguerreotype, for example, of two figures in black bronze, with a high metallic lustre, it is impossible by looking at either of the pictures, to tell the materia's of which they are made. No lustre is visible; but when the two equally shaded pictures are combined in the stereoscope, the lustre and true character of the material is instantly seen. Another instructive example is seen in the stereoscopic representations of a boy blowing a soap bubble. The lustre of the watery sphere is not visible in either of the two pictures, but when they are combined it is distinctly seen. In both these cases, and others of the same kind, tints of similar intensity are combined, and there is no ground for assuming that the two surfaces combined appear at different distances, and that the one is seen through the other, as n Professors Dove's theory.

A report from the Balloon Committee, submitted by Colonel Sykes, stated that the past exertions of the Committee, appointed at a former year's meeting, had not been attended with success. It was recommended that the Committee be now re-formed, with a grant of £200.

Professor Hennessey submitted a "Provisional report on the present state of our knowledge on the transmission of sound signals during fogs at sea," followed by a paper "On the connection between storms and vertical disturbances of the atmosphere."

Mr. Glaisher read a number of communications on a deep sea pressure gauge; on a deep sea thermometer; on a daily weather map; on Admiral Fitzroy's paper presented to section A relative to the Royal Charter storm; and on some meteorological documents relative to Mr. Green's balloon ascents.

Mr. W. Hopkins next read a paper "On the theories of glacial motion."

THE EXCESSIVE COLD OF CHRISTMAS, 1860.

Mr. E. J. Lowe submitted a communication "On the great cold of last Christmas, and its destructive effects." He said that the excessive cold of Christmas, 1860, near Nottingham, being perhaps, as great, if not greater than had ever occurred in England since the invention of the thermometer, it appeared desirable to record so unusual

a degree of cold, together with its destructive effects in the midland counties. Some idea of the fearful ravages amongst trees and plants might be gathered from the fact that not only had numerous branches of the oak been damaged, but, in some instances, large trees themselves had been killed. The summits of hills had escaped much of the ravages of the frosts that had been so seriously felt in the valleys. He gave a long list of the destruction of trees and plants as recorded in the report at the Highfield House Observatory, and stated that the destruction to birds and insects was also very great. One circumstance with regard to this excessive cold, which he recorded at the time, he wished to repeat. He alluded to large icicles forming at the nose of a horse, a phenomenon, he understood, that was more or less doubted. Nevertheless this phenomenon occurred, for he saw it himself, and even took hold of the icicle. But it did not rest on his testimony alone. As the vicar's churchwarden of Beeston, he had the management of the decorations for the Christmas festival, and it was whilst conveying evergreen wreaths from the schoolrooms to the church, accompanied by a number of ladies and teachers of the schools, that this phenomenon was seen. He called attention to the icicles as a most remarkable occurrence. These persons were ready to corroborate his statement, as was also the owner of the horse. He had since learnt that another horse belonging to a farmer in the parish, had a similar appendage to its nose. Turning to the temperature, there were frosts every night, from the 12th of December to the 19th January, the temperature on the grass on the coldest nights, being from 21° 5′ on the 18th of December, down as low as 17° 5′ on the 10th of January. At four feet above the ground the greatest cold was on the 24th of December 0° 5′, and on the 25th, 8° 0′. The mean temperatures of the coldest days were, 13° 3′ on the 24th, 4° 0′ on the 25th, 22° 6′ on the 26th, 23° 6′ on the 28th, and 21° 7′ on the 29th. The greatest heat only reached 12° on the 25th and only 16° in full sunshine. During this excessive cold weather he had delicate theremometers placed at various heights above the ground, up to 27 feet. These instruments were used constantly. The thermometers were all compared with the standard presented to him by the British Association. He named this as he was aware that a number of meteorologists conceived that the records given were impossible for the climate of England, and his friend Mr. Glaisher, he believed, was of that opinion. Nevertheless, he had the confirmation of 27 instruments placed on and above the ground, and also on his observatory, and giving a temperature of from 7° to 14° below zero, according to the circumstances under which they were placed, and all exceeding the limits, he believed, according to the views of Mr. Glaisher. He could vouch for the accuracy of the readings of his instruments; and, as he had an equal number of mercurial and spirit thermometers, it could scarcely be possible for the temperature given to be far from the truth. Whatever might be the opinion as regarded the actual temperature, there could be no doubt as regarded the destruction, which exceeded anything remembered by the oldest person. In 1854 a temperature of 4° below zero destroyed many trees, but the destruction in 1860 was very much greater.

Mr. Glaisher discredited the statements advanced by Mr. Lowe, contending that it was impossible for the temperature to be so low in our climate. He attributed the indications given by Mr. Lowe to the imperfect condition of his thermometers.

In the discussion which followed, several gentlemen supported Mr. Lowe's statements.

Mr. Lowe, in reply, adhered to the literal truth of his statements, and claimed for his thermometers minute accuracy.

COMPENSATION OF IMPRESSIONS MOVING OVER THE RETINA.

Sir David Brewster read a paper "On the compensation of impressions moving over the retina." He said that when, in railway travelling, they looked at the lines which the stones, or gravel, or other objects formed in consequence of the deviations of their impressions on the retina, and quickly transferred the eye to the same lines further back, where the velocity was slower, the stones, or gravel or other objects would, for an instant, be distinctly seen, just as they saw distinctly, rapidly revolving objects in the dark when they were illuminated by an electric flash, or the light of an exploded copper cap. A similar, but not the same phenomenon, might be seen when they looked at the moving lines through a slit and quickly looked away from the slit, so that the lines might be seen by indirect vision on a part of the retina not previously impressed. This class of phenomena might be best studied by a rapidly revolving disc, by quickly transferring the eye from the lines on the marginal part of the disc to those near the centre of rotation, where the velocity was less. They accordingly found that when the marginal velocity was greatest, the point of compensation was nearest the centre, as might have been expected from the experiment in a railway carriage; but what could not, he thought, have been anticipated, was that the point of compensation was not in the same radius as the point to which the eye was first directed. He explained this statement by means of a diagram which was exhibited. He had not been able to see the point of compensation close to the centre of rotation, where it doubtless must be with a certain velocity, so that its locus must be in a curve.

PHOTOGRAPHIC MICROMETERS.

Sir David Brewster next read a paper "On photographic micrometers." He said that upon examining, several years ago, some microscopic photographs, executed by Mr. Dancer, a celebrated optician in Manchester, he was struck with the singular sharpness and opacity of some of the lines in such of them as were copies from engravings. The idea occurred to him of obtaining photographically, by means of the camera, "micrometrical scales," or systems of delicate lines, opaque or transparent, and fitted both for astronomical and microscopical purposes. In the "Encyclopædia Britannica" he had stated that Mr. Dancer, of Manchester, had succeeded in making photographic portraits on collodion so small that they were wholly invisible to the naked eye, and that 10,000 portraits might be introduced into a square inch. The film of collodion upon which these photographs were taken was so thin and transparent that it was invisible, and allowed objects to be seen through it as distinctly as if it was the thinnest glass. It was obvious that they might construct, photographically, the various *recticula* or *reticles*, as they had been called, used by Cassini, Bradley, La Caille, and Mr. Wollaston, as well as the net micrometer, the concentric circle micrometer, the suspended micrometer of Fraunhofer, and the lineal and circular micrometers of Cavalio, and others drawn upon mother of pearl.

Mr. C. W. Siemens next read a paper "On the bathometer—an instrument to indicate the depth of the sea without submerging a line;" and Mr. Balfour Stewart offered some observations "On the photographic records given at the Kew Observatory of the great magnetic storm of the end of August and beginning of September."

It being now three o'clock, the section adjourned, several of the papers which were to have been read being postponed until this forenoon.

Section B.—CHEMICAL SCIENCE.

This section met again at Owens College. The President, Professor W. A. Miller, M.D., F.R.S. took the chair at a quarter past eleven.

Professor Tomlinson read a paper "On the cohesive figures of liquids." He said that when one liquid was added to another there were the two forces of cohesion and adhesion. If he took a drop of oil of lavender on the end of a glass rod and deposited it gently on the surface of the water, he got a very beautiful defined form, which immediately opened into holes, and from these holes branched forth the most complicated pattern which was represented by one of the diagrams arranged on the wall of the Theatre. He proposed to call it a cohesive figure. It arose from the struggle which took place between

the cohesion of the substances and the adhesion of the water. He would give a very few conditions upon which these cohesive figures depended. A substance like creosote was not very soluble in water. A drop of it placed on the surface of the water got a crispated figure violently agitated. The edges were crispated like some beautiful pectunated shell-fish: the agitation continued for a considerable time, and there was a powerful struggle going on between the creosote and the adhesion of water. He believed the forms produced by the different liquids were typical of the substances experimented upon. Doctor Tomlinson illustrated his remarks with many experiments. He considered that the variety of beautiful forms produced by the action of the different substances might afford valuable suggestions to the artist in enabling him to make new patterns. The experiments would form a rapid mode of detecting adulteration, and the nature of the substance made use of in the process of adulteration.

Mr. Archer and Mr. Deane considered that great care was necessary in ascertaining the appearance pure substances presented, before similar substances, said to be pure, but presenting different appearances could be safely pronounced as adulterated.

Professor Tomlinson, in reply to Professor Crace Calvert, said that differences of opinion only hastened or retarded the experiments.

The President said that there were so many papers to be read, that time would not admit further discussion upon this subject. Whether Professor Tomlinson's original diagrams were correct or not, mattered little at present; the principle upon which he had started was the important point. He considered all were indebted to Professor Tomlinson for opening a new field of investigation.—(Applause.)

CONSTITUENTS OF MANURES.

Professor Voelcker, of the Royal Agricultural College, Cirencester, read a report "On field experiments and laboratory researches on the constituents of manures essential to cultivated crops." The following were the results of field experiments on turnips in 1860: The great superiority of phosphatic matters, as manuring constituents of the root crops, is proved. A sufficient quantity of valuable phosphates render other fertilising matters superfluous on a soil like that on which the experiments were tried. Ammoniacal salts do not appear to have any specific effect on the turnip crop. Alkaline chlorides and sulphates produce no effect. Nitrate of soda had a beneficial effect upon the turnips. Sulphate of lime was inefficacious as a fertiliser for swedes on the experimental field.—The experiments on wheat gave the following results: Nitrate of soda and salt produced the greatest increase in grain and straw, corresponding with the experiments of 1850. Nitrate of soda applied by itself, was not quite so beneficial, but gave a large increase of grain and straw. Common salt scarcely increased the yield of grain, and reduced the yield of straw. Next to nitrate of soda, Peruvian guano was the most efficacious and most economical manure for wheat. The results of the experiments on barley correspond very nearly with those on wheat. The results of all these experiments showed that through the instrumentality of purely nitrogenous manures the produce of our grain crops might be very considerably increased, whilst the same manures appear to have no beneficial effect upon root crops on the experimental soil. From his laboratory experiments he found that nitrate of soda had no influence on the solubility of phosphate of lime, for the differences in the amount of phosphate of lime obtained from solution containing one per cent of nitrate of soda, and from distilled water left in contact with phosphate of lime, were too small to be due to any other cause than to the necessary errors which attach to all the analytical determinations of this kind.

The President said that before discussion commenced on this Report he would call upon Dr. J. H. Gilbert, F.R.S. to read a paper upon a similar subject. Doctor Gilbert accordingly read a paper which he, in conjunction with J. B. Lawes, F.R.S had prepared, "On some points connected with the exhaustion of soils."

Mr. Gilbert said that the question of the exhaustion of soils, was one of peculiar interest at the present time, not only on account of the great attention that was being paid to the waste of manuring discharged into our sewers in the form of town sewage, but also from the fact that Baron Liebig had recently spoken of the progressive exhaustion of our own soils from this cause. They had grown wheat year after year, without manure, and with different constituents of manure, for 18 years, grass consecutively on the same land, and determined the amount of the different mineral constituents taken off from each plot. Numerous tables of results were exhibited. It appeared that when ammonical salts were used alone, year after year, on the same land, the composition of the ash of both grain and straw showed an appreciable decline in the amount of phosphoric acid, and that of the straw showed a considerable reduction in per-centage of silica. The acreage yield of mineral constituents was very much increased, and the use of ammonical salts were much more so than when a liberal supply of mineral constituents alone was used; but in neither of these cases was there anything like the yield of mineral constituents, in the produce per acre, that there was when the ammonical salts and mineral manures were used together, or when farmyard manure was employed. The greatest deficiency indicated was in the silica and the phosphoric acid, and next in order came magnesia and potass. The exhaustion here apparent was, however, not astonishing, when it was considered, that in these experiments both corn and straw had every year been removed without the usual periodical return of farm-yard manure. There had been taken from the land in 16 years, by the use of ammonical salts, as much silica as would require 400 years, as much phosphoric acid as would require 32½ years, and as much potass as would require 82 years of ordinary rotation with home manuring, and selling only corn and meat, to remove. Again, in the experiments of the Rev. Mr. Smith, of Lois Weedon, on the growth of wheat, year after year on the same land without manure, they had estimated that he annually took from the land about seven times as much potass, about 3½ times as much phosphoric acid, and about 37 times as much silica as the ordinary course of practice would do; and yet after some fifteen years his crops were said to be, not at all failing. It was impossible to state the limits of the capability of various soils; but it might be useful to give an illustration of this point. Taking the average of 42 analyses, of 14 soils, of ordinary rotation, with house manuring, and selling only corn and meat, it was estimated that it would take nearly 2,000 years to exhaust the potass, 1,000 years to exhaust the phosphoric acid, and nearly 6,000 years to exhaust the silica, found to be soluble in dilute hydrochloric acid. Much of the mineral constituents, even of the corn and meat, was returned to the land; whilst much of the matter entering the sewers was derived from imported food. Whilst they believed that modern practices did not tend to exhaustion in anything like the degree that had been supposed by some, they would nevertheless insist upon the importance of applying to agricultural purposes, as much as possible of the refuse of our towns.

Mr. William Wallace, of Glasgow, read a paper on the composition and properties of the water in Loch Katrine, as supplied to Glasgow. He said that he had made more experiments on the water, and the result he had come to was this:—that the amount of lead taken up from the pipes and cisterns at the present time was not such as to give rise to serious alarm.—Dr. Clarke said, that where water had become contaminated with lead, so as to be dangerous, the lead could be got out of it by the simple process of passing the water through a sand filter.—Dr. Grace Calvert, F.R.S. said that he would not have troubled his section with bringing before them this subject which had been noticed several times by them already, if these researches (which were made in

connection with a select committee of the Sanitary Association of this city) had not presented several points of interest: namely, the action on lead of a water supplied to a large population; the determination of the quantity of lead that the same water took up in a given length of time; and further with the hope of removing the impression from the minds of some chemists, that soft surface water does not act upon lead. These experiments had extended over a period of more than twelve months, and above 800 samples of water had been tested, and led to the following conclusions:—That the water supplied to Manchester and passing through a lead pipe, used as a supply pipe, was for four days highly charged with lead compounds, and that the quantity gradually decreased for six weeks, when the water ceased to absorb lead. But if during that time the water were allowed to remain in contact with the pipe for twelve hours, its action was still very marked, and at the end of six weeks the water still contained two-tenths of a grain of lead per gallon, and after six months one-thirtieth of a grain was to be found. He concluded his remarks by stating that in allowing water to remain some time in the pipes, and then again bringing them into constant use, the action of the water on the pipes was greatly increased.

Doctor MACADAM read a paper "On the proportion of arsenic present in paper hangings." He said that during the last two years attention had been called to the subject of arsenic in paper hangings. That arsenic papers were injurious to health, had been brought under his notice by several of his professional medical brethren, who had been satisfied that their patients had the preliminary symptoms of poisoning by arsenic. He related a few instances, from which it appeared that the patients who had been affected with the symptoms of arsenical poisoning recovered their health on ceasing to occupy the bedrooms which contained the arsenic papers. He was aware that the question whether the arsenic in paper hangings was injurious was still under discussion. In the majority of green paper hangings arsenic was present in rough powder. He was told that generally flock paper did not contain arsenic. He exhibited several green papers in which arsenic was deposited in a rough condition. When he struck one of them with his hand, a cloud of dust arose; it was arsenic, which had been placed over the surface of the paper. In those packages of envelopes where there were 25 to each package, each packet was packed in a band of green paper to keep the envelopes together. If one purchased two packets or 50 envelopes here was to be found 2.3 grains of arsenic in the green paper bands. He had found as much as 40 grains of arsenic in the square foot of green paper. During the ordinary process of cleansing and switching a great deal of arsenic would be brought down, it would lie on the floor and the bed-clothes. The papers were placed upon the walls of the rooms in a damp condition, and the paper became damp during the process of respiration, and the arsenic was liable to be carried off in the condition of water. With regard to the injury such arsenic papers had upon the system, the injury in no case was carried so far as to lead to actual poisoning.

Professor WILLIAMSON considered that Dr. Macadam's interesting paper contained assumptions which appeared not sufficiently supported. Dr. Macadam assumed that under the circumstances to which these papers were exposed, certain portions might be volatilised. From the first, statements had been made which were extremely careless upon this subject.

Professor GALLOWAY must take exception to that part of Dr. Macadam's paper which spoke of arsenic being decomposed by water. He supposed it might take place, and then spoke of it as if it had taken place. He agreed with Professor Williamson that it was unwise to disturb the public mind with this question. He understood that the persons living where the manufacture of these substances was carried on were found to be perfectly healthy.

Dr. MACADAM replied that he was as desirous as anyone not to create needless alarm. But there were cases in which his medical brethren in Edinburgh had visited persons suffering from arsenical poison who were occupying bedrooms having green paper-hangings. The proceedings of this section concluded about four o'clock.

SECTION C.—GEOLOGY.

This section resumed its sittings at the Royal Institution yesterday morning, at the usual hour. Sir R. I. MURCHISON in the chair.

GEOLOGICAL SURVEY OF TASMANIA.

The PRESIDENT communicated the results of the geological survey of Tasmania by Mr. C. Gould. The formation treated of were the upper Palæozoic marine deposits and the coal measures. The apparent conformability of the two sections was shown together with their intimate connections, serving to render their consideration inseparable. The coal measures exist to a greater or less extent through the country referred to, the depth being about 1000 feet. The coal measures of the district might be regarded as constituting two distinct fields, the maximum one of which might be termed the Mount Nicholas Coalfield, comprehending the various portions developed upon either side of the Break o' Day Valley, while to the other the term Douglas River Coalfield might be applied, as indicating the area occupied by the carboniferous formation between Long Point and Bicheno. In the first the position of the principal seams of coal, although highly advantageous to their being worked, is at an elevation of from 1,200 to 1,500 feet above the sea. There were at least six distinct seams in the Mount Nicholas coalfield—one of which was of superior quality, and 12 feet in thickness. Ever since the discovery of the seam experiments have been made, which, though amply sufficient to prove the value of the coal for domestic purposes, and for application to the usual branches of manufacture, have been upon too limited a scale to permit of the determination of its value as a steam fuel. A remarkable shale exists in the north of the island available as a source of paraffin and paraffin oil. The Mersey coalfield was one of very few in Tasmania which is actually worked; for, although the extent of coal throughout the island is almost unlimited, there are very few points at which any operations are conducted.—After some discussion, the section proceeded to the next paper.

THE FAULTS OF THE LANCASHIRE COALFIELD.

Mr. HENRY GREEN communicated a paper "On the faults of the Lancashire coalfield." The essayist proposed to point out a law which appears to govern the direction of the principal lines of fault in the Lancashire coalfield, and to endeavour to show, on the principles laid down by Mr. Hopkins, that this law is a necessary consequence of the forces which produced the upheaval of the coalfield. On the eastern and northern sides the coal measures are bounded by millstone grit, which rises conformably far beneath them. The intensity of upheaval along the eastern boundary was certainly great, as might be expected from its proximity to the central upheaval of England, and there seems reason to believe that it increased in magnitude northwards. The force of elevation along the northern boundary seems also to have increased towards the east; since it would appear that the north eastern was a point of maximum elevation. On the south, the coal measures pass regularly but unconformably beneath the permean and new red sandstone formations, the boundary line being deeply indented by faults, along which promontories of new red sandstone run up into the heart of the coalfield. That the portion lying between the Upholland and boundary faults contains the same measures, and has been acted upon by the same forces of elevation as the main body of the coalfield, cannot be doubted; but its position without the basin, and some irregularity in the directions of its lines of fault lead me to think that local causes have chiefly determined the arrangement of its measures [illegible] would appear

that the elevating forces have acted with greatest intensity along the northerly and easterly boundaries, increasing in each case towards the north-east corner. It appeared also that the western boundary has been a line of upheaval of smaller and more uniform intensity, and that towards the south the amount of elevation has decreased to a minimum. The upheaval area may be roughly supposed to be oblong in shape, its longer axis running in an east and west direction, and while its southern and western sides remained fixed, its north-east corner was elevated in a vertical direction. As to the extension of lines running north and south across the area, it is evident that it will increase as we recede from the western side, in fact, it varies very nearly as the square of the distance from that side. In the same way the tension of a line running east and west will vary very nearly as the square of its distance from the southern boundary. Thus, over the uplifted area there will be two sets of parallel tensions, the one acting in a north and south direction nearly, and increasing in magnitude from west to east; and the other in an east and west direction nearly, and increasing in magnitude from south to north. The alteration in the shape of the area produced by its extension will make the lines of tension deviate a little from a northerly and easterly direction, so that the angle between them will never be quite a right angle. The essayist had applied Mr. Hopkins's calculations to the present case, and obtained the following results with regard to the direction of the first formed set of fissures:—1. When the two tensions are equal, a fissure will tend to be formed in a direction at right angles to the line bisecting the angle between them. 2. When the tensions are unequal, in which the tendency to form a fissure is greatest, makes a larger angle, with the direction of the greater tension than with that of the other—this angle tends to a right angle as its bisecting valve. Now, since one tension depends only on the distance from the western boundary of the area, and the other on the distance from the southern boundary, the tension will be equal when these distances are equal. Hence, in every part on this line the fissures will tend to run in a north-west and S.E. direction. The line just mentioned will divide our area into two parts—a triangle and a quadrilateral. The distance of every part in the triangle from the southern boundary (and hence the easterly tension) is greater than from the northerly one. The difference, too, increases as we go northwards; hence the lines of fracture will tend to change from a north-west and south-east into a north and south direction more and more as we go further north. Similar reasoning will show that in the quadrilateral the direction of the fissures will tend to become more and more nearly east and west as we go towards its north-east corner.

The PRESIDENT complimented Mr. Green on his valuable paper, stating that the application of applied science to geology was an important era in the latter.—Professor SEDGWICK also bore testimony to the value of Mr. Green's paper.—Mr. BINNEY said he could testify to the correctness of the direction of the faults laid down by Mr. Green. There was a remarkable difference in the faults of the Lancashire coal field compared with those of Cheshire and Derbyshire. Nearly all the faults in this neighbourhood took a north-west and south-east direction, but those in the neighbourhood of Macclesfield and Stockport took a north-west direction.—Mr. DICKINSON remarked that if any law could be laid down by which to trace these faults without actual observation, it would be of great value. There was a remarkable feature in this coalfield which was not shown upon Mr. Green's diagram, nor upon the Ordnance maps; namely, that two faults traversed the country from Church eastwards, running north east and west between Todmorden and Burnley.—Professor ROGERS said the law of faults laid down by Mr. Green was far from being universal. Having investigated wide tracks of "faulty" country, he found that where there was a series of undulations, and there had been a distention or stretching, there was a slanting fault; where there was a compression of the strata the reverse was the case.—After some further remarks from Professor Rogers, Mr. Dickinson, and Professor Sedgwick, the section proceeded with the next paper.

NEW FOSSILS, &c.

Mr. EDWARD HULL contributed a paper on "Isometric lines and the relative distribution of the calcareous and sedimentary strata of the carboniferous rocks." The essay, which entered at great length into the subject it discussed, was of a very abstruse character.

Professor HARKNESS communicated some observations on the old red sandstone of South Perthshire, in which he mentioned the discovery of some new fossils, and pointed out the peculiar geographical condition of the country in which those fossils, which comprised eleven distinct species of fishes, were found.

The Rev. Dr. ANDERSON read a report on "Dura Den." The report stated that last year the Committee of the Association made laborious researches in quest of the long-lost *pamphrachus* of Agassiz, nowhere seen nor heard of in any part of the above-named rocks for a period of twenty-five years. He had now to state that in their latter excavations they had come upon the hidden treasures, and he had the pleasure of laying them upon the table, in a condition of the most perfect preservation. There was a double interest connected with this curious crustacea. First, of a rare discovery; and next, of a successful result in a matter of keen and important controversy. The specimens discovered were five impressions of the Pamphractus Andersoni, two of which were perfect in all their plates, whilst the others were more or less mutilated in some of their organisms. Besides this genus, the excavations had revealed at least one other entirely new to science. The specimen of this new fossil, which he laid upon the table, was in a sufficiently good state of preservation for determining all the true characteristics of the genus in scales, fins, plates, and general contour. The caudal and pectoral fins were enormously large, the body short and small, and the head comparatively very large. He concluded by remarking that, with regard to the chief object of their researches, the Pamphractus of Agassiz, he had now the pleasure of laying on the table the original plate, which gave rise to a discussion at the meeting at Edinburgh, in 1850, and afterwards challenged inaccuracy, and was afterwards subjected to not a little severity of criticism. The plate in question constituted the first figured design of the fossil; and having compared the one with the other, he found it was carefully drawn.—Papers were afterwards read by Mr. W. PENGELLY, "On the relative age of the Petherwin and Barnstaple beds;" by Mr. A. HUGSON, "On the aqueous origin of granite;" by Mr. PENGELLY, "On the age of the Dartmoor granites;" and by Mr. J. W. SALTER, "On some points in the structure of sigillaria, and on the bivalve shells in the coal measures." Thanks were voted to the authors of the several essays, and the section adjourned.

SECTION D.—ZOOLOGY AND BOTANY.

Professor BABINGTON took the chair at eleven o'clock, in the Gallery of Antique Sculpture at the Royal Institution.

Dr. P. P. CARPENTER read some "Notes on the variations of Tecturella grandis;" and then spoke "On the cosmopolitan operations of the Smithsonian Institution." He described the principles of the expeditions sent out by the United States government, and the system of private correspondence which had been established. The institution was also in direct connection with the Lighthouse Board and Coast Survey, by which easy access was obtained to some two thousand persons in the lighthouses, and along the whole Atlantic coast, in the Gulf of Mexico, and the Pacific coast of North America. One most important collection had been obtained from the entrance to the Gulf of California, where the two streams meet, and which had been made by Mr. Zanthus, one of the agents of the Coast Survey. The specimens in the Free-trade Hall were sent across for his (Dr. Carpenter's) examination, free of cost, and were allowed to enter

with very little examination—an important thing in such a case. The captains of the American mercantile marine rendered valuable assistance; and Dr. Carpenter strongly hoped that the plan proposed by Dr. Collingwood as to our own mercantile marine would be fully carried out. According to the scheme of the Institution, duplicate type specimens are distributed as widely as possible to scientific institutions both in America and abroad, that they may be used in identifying the species and genera described. To promote education as fully as possible, the general duplicates are presented to colleges that profess to teach the principal branches of natural history. But in all cases it is required that credit is to be given in the labelling of the specimens, and in any description published of them, "as vouchers to the world that they are carrying out faithfully the intentions of the bequest." The collection in the Free Trade Hall Dr. Carpenter said he was at liberty to offer to the British Museum, if certain red-tape difficulties did not stand in the way. If a naturalist wished to work out some particular thing, he had but to convince Professor Henry that he was honest and sincere, and the professor was then at liberty to send over the whole of the unworked material, which the naturalist could keep as long as was necessary for his purpose.

The PRESIDENT said it was sincerely to be hoped that the present disturbed state of America would not interfere with the operations of the Institution; but there was strong reason for fearing that such would be the case. Dr. Carpenter had informed them that the funds of the Institution were in the hands of one of the Southern states, and could not at present be got at; and very probably both north and south would for some time have difficulty in raising money that they wanted for other purposes.

DR. GRAY, PROFESSOR OWEN, AND THE GORILLA.

The PRESIDENT then read the following letter from Dr. Gray:—

British Museum, September 6, 1861.

My dear Professor,—It is with much regret that I feel myself called upon to correct an error which appears in the report of Professor Owen's paper on the gorilla, &c contained in the *Times* of this day. Professor Owen is there represented as stating that "the skin of the great gorilla now in the British Museum exhibits two opposite wounds, the smaller in front of the left side of the chest, the larger close to the lower part of the right blade bone. Two of the ribs in the skeleton of this animal are broken on the right side, near where the charge has passed through the skin in its course outwards." As this would appear to offer a direct contradiction to a statement made by myself, I cannot (although labouring at present under a severe attack of illness, and writing from a sick chamber) pass it over in silence. My attention was called to the subject by Mr. Joseph Beck, the well-known microscopist, who first made the observation, that none of the skins of the gorilla exhibited by M. Du Chaillu offered any evidence of having been shot in the forepart of the chest, as invariably stated in his "Narrative." My own examination entirely confirmed this remark, and the unanimous conclusion of numerous sportsmen and men of science, who have since examined both skins and skeletons, has been to the same effect. The skin and skeleton referred to in Professor Owen's paper are both, as stated, in the British Museum. While the skin was being stuffed at the Crystal Palace by Mr. Wilson, I paid a visit to that establishment, in the company of Mr. Grove, the secretary, and several friends. I then inquired of Mr. Wilson whether he had observed any bullet-hole in the chest, and he stated that he had not, but pointed out to me two holes in the nape of the neck (now filled with putty); there are also two large holes in the thin portion of the hinder part of the skull belonging to the same skin which pass through the bone, and are quite sufficient to have caused death. In neither skin nor skeleton is there any evidence of a gunshot entering on the left side of the chest; and the fracture of three (not of two) ribs on the right side beneath the scapula, and the supposed corresponding rent in the skin, are so utterly unlike the effects of a gunshot, that no sportsman could possibly so consider them. These are facts so easily verified that I trust all who feel an interest in the subject will examine and decide for themselves. I might cite many names of high authority in corroboration of what I have here advanced, but I am not disposed to appear to any authority, however great, where the facts are open to the inspection of all. On these, and these only, I rest my case. I shall be obliged by the reading of this letter in the Natural History Section, and remain, yours faithfully,
JOHN EDW. GRAY.

Professor Babington.

The President added that he had addressed a note to Professor Owen, hoping that he would be able to meet and converse with him on the subject. But, unfortunately, the Professor was just on the point of leaving Manchester for two or three days, and was at that moment away. He had received a note, from which Professor Owen requested him to read a few words; but as he did not know the nature of Dr. Gray's letter, he could not, of course, answer it. Professor Owen said that he merely recorded his observations of two points or holes in the stuffed skins of the great male gorilla—one small and the opposite one large; the two ribs opposite had been fractured, just before death, and the fractured end was stained with blood, there being no evidence of repair. His observations were made before as well as after the stuffing of the skin.—Mr. P. L. SCLATER (Zoological Gardens, Regent's Park) said that when he examined the skull, he thought he saw a bullet mark in the back of it. He had asked Professor Owen whether he had observed it, and received an answer in the negative. He had not made any special observation of the skin; but he had put the question to Mr. Bartlett and Mr. Wilson, who prepared the skin, and they both told him that there was a hole in the neck.—Mr. JOSEPH BECK said that, as his name had been mentioned by Dr. Gray, he wished to say that he could not observe these bullet wounds. In the absence of those most interested, he did not think it right to call their statements in question, or to bring forward what one imagined to be proofs in the case.—Dr. LANKESTER said he had communicated to M. Du Chaillu the substance of Dr. Gray's letter. That gentleman's reply was, that the charge was an old one; and that, as he had answered it so frequently, he did not think it necessary to come and answer it again. Communications were read by Mr. H. T. Stainton, "On a new mining larva recently discovered;" and the Rev. T. Hincks, "On the development of the hydroid polyps, clavatella, and stauridia, with remarks on the relation between the polyp and its medusoid, and between the polyp and its medusæ."

COTTON FROM THE AMAZON.

Dr. LANKESTER read a paper, communicated by Mr. W. Dawson, "On Barraguta cotton from the plains of the Amazon, and on the flax fibre cotton of North America." The writer states that he has known the vegetable substance called Barragude cotton for more than 20 years, a small import having been received from Peru *via* Cape Horn about that time. It was represented as the produce of a very large tree, 30ft. to 40ft. high, and the cotton, when ripe, hangs down to the ground by its own fibres connected. Yet the consumers state it will not spin—a customary objection to anything new. More recently a similar import—about half a dozen bags of 70lb each—came from the River Plate *via* Pernambuco. Any quantity can be had from the east side of the Andes and the plains of the Amazon. As to the staple of the cotton, it is very silky and short; but by grafting, or superior technical cultivation known to naturalists, it might no doubt be improved. Large quantities must be brought to market, and then machinery will be altered to suit its working, as was the case with alpaca, which has a silky fibre. He sold one bag of the Barragude cotton at 3d. per lb; but, as the Yorkshire buyer did not accept delivery,

the whole of the last lot was taken by the importer for stuffing sofa cushions and mixing in feather beds, instead of purchasing swandown at 12s. 6d. per lb. Here is a large field for the use of such fibres; and if brought to this country in large quantities, it must be mixed with cotton, like mump or devil's dust, or be spun up with sheep's wool. Through the kindness of Mr. M. J. Whitty, of the *Liverpool Daily Post*, the writer was authorised to exhibit a sample of new fibre from the wild flax of North America. Millions of bales, he states, can be obtained at a cost of less than 4d. per lb, so profusely does the wild flax exist. These new fields ought to command attention when there is so much anxiety to increase the supply of cotton. The author contends that six million acres of land in Ireland can be had at a nominal rent, on which good cotton can be grown, the land never having been grazed, scratched, or nibbled by cattle.

After the reading of a paper by Mr. J. Cowburn, "On the culture of the vine in the open air," the section adjourned.

Sub-section D.—PHYSIOLOGY.

Professor Babington presided in this section, which again met at the Royal Institution.

THE BRAIN IN MAN AND ANIMALS.

Mr. Garner, F.L.S. read a paper on this subject. In this paper the author adverted to the extreme doubt still dwelling in the minds of physicians and physiologists with respect to the functions of the different parts of the brain. He took up the theory that the cerebellum is not the organ of amativeness, as maintained by Gall, but the distributor of the motive impulse descending from the cerebrum. His proofs were derived from comparative anatomy, and from the development of the cerebellum at different ages, as well as from a remarkable case of disease. He also endeavoured to localise the sources of its different kinds of influences. With respect to phrenology, he observed that its list of faculties and feelings is very complete, whilst one half of the convolutions, their supposed seats, do not appear on the upper surface of the brain at all, or influence the form of the skull. He next endeavoured to prove the functions of the component parts of the brain, and traced the development of the convolutions from the smooth brain of the rodentia to that of the ape or man. The distinction and description of these folds is not without the pale of anatomy, and their consideration forms the transcendental plan of arranging the mammalia. He made a few observations on the general form of the cranium. Females, he thinks, have by no means, comparatively speaking, low foreheads, but the reverse, at least centrally; their skull is also more lozenge-shaped, a little prominent at the sides. He thinks men of low or moderate stature have commonly an advantage in cerebral development, but the convolutions in a small brain are oftener richer or more numerous and tortuous in their divisions than in the other case, and some eminent men have had very small heads. With regard to the boat-shaped or long head skull, from before to behind, and the rounder and broader form, the differences, sometimes perhaps national, may be in others only individual; the author thinks that the former variety has in some respects (the exact studies for instance) very frequently the advantage.

PRISON DIET IN INDIA.

Dr. Mouat, inspector general of prisons in Lower Bengal, read a paper on the diets of prisoners in the jails under his superintendence, as affecting the health of the convicts confined in them. He commenced by giving a brief history of the successive dietaries in use in Bengal; and then proceeded to detail the results of an inquiry which had been made into the sanitary influences of the existing dietary. He stated subsequently the principles that should guide the formation of a prison dietary, applied those principles to the dietary in use, and concluded by suggesting the remedies necessary to correct the errors of that scale of food, without losing sight of the primary objects it is intended to fulfil, namely, to maintain the health of prisoners at the lowest possible cost to the state, so as, on the one hand, to avoid improper indulgences, and, on the other, to secure a sufficiency of food to preserve health and prevent disease. Facts and figures were produced to show connection between the diet scales and the mortality from diseases most nearly associated with the functions of digestion—dysentery, diarrhœa, scurvy, phthisis, and cholera, of which the connection was believed to be very doubtful. The dietetic value of the chief articles used as food in the prisons of Bengal, was given on the authority of the analysis propounded by Dr. Forbes Watson, and four different scales of diet were recommended: 1, for Bengalese and Assamese; 2, for natives of Behar, the North-West Provinces, and the Punjab; 3, for Coles, Sontals, Garrows, and Hillmen generally; and 4, for Mughs and Chinamen. The last-named were fond of cats, dogs, rats, or any animal food, and mere vegetable diet never satisfied them. The scales referred to were all for long-term convicts, and were stated to be the minimum to maintain health and strength.

Dr. E. Smith said the Indian government was to be congratulated upon the possession of such an officer as Dr. Mouat. In this country, we had no one like Dr. Mouat who had control over our various prisons; and in this respect we had certainly something to learn from India. He hoped that Dr. Mouat's paper would not be allowed to lie in the Indian archives, but that the principal prison authorities in this country would at least be supplied with copies. He wished to enforce his opinions that no dietary could be reckoned upon the gross weight of food supplied; it could only be done upon the weights of the particular kinds of food. It was very important that the principles upon which a dietary was to be constructed were agreed to both in India and this country; and his conviction was, that we had arrived at the knowledge that would enable us to appropriate the amount of food required for the several conditions of prisoners, so as to allow them to leave prison in the same state as that in which they entered it.—Sir John Richardson remarked that nothing had been said about cooks. There might be a great fallacy in saying that the prisoner got a given quantity of food; for very much of it might have been destroyed by bad cooking. He believed that the working classes generally in this country destroyed at least one third of their food in this manner. The statistical estimate of the number of deaths in prison was not a true measure of the effects of food. A prisoner might be confined for only a short time; he might have in him the seeds of ill health; and scrofula or some other disease might be produced by defective nutriment, of which the man died after leaving prison.—Professor O'Leary asked whether Dr. Mouat had, when forming his scales of dietary, examined the teeth of the four races of which he had spoken. He believed that in the form of the teeth, not only of the canines but of the molars, there might be said to be a photographic impression in the mouth of man, of what food he required. This was well shown in some remains which he had examined from an old cemetery in the south of Ireland. There were in that part descendants from Scandinavian settlers, who came over 700 or 800 years ago; as well as of those who were called Palatiners. He found peculiar indentations in the molars of some of these old Scandinavian remains, which accounted for the rapid decay of the teeth of the Saxons as compared with those of the Celts; and it was well recognised in the south of Ireland that the descendants of the Scandinavians could not thrive without an amount of animal food, which the Celts did not at all require.—Dr. Mouat said he had considered only the food which the several races took in a state of liberty. This he considered all that was necessary; for the people would adopt that kind of food for which their teeth were best adapted.

Dr. E. P. Wright read three communications from Professor Hyrtl, "On nerves without end;" "On the

pneumatic processes of the occipital bone;" and "On portions of lungs without bloodvessels."

ANATOMY OF INSECTIVORA.

Professor ROLLESTON read a paper "On some points in the anatomy of insectivora." He confined his attention chiefly to the mole, the shrew, and the hedgehog—the three species found in this kingdom. The subject, he said, enabled us to illustrate principles of first-rate importance. He gave a number of details as to the osteological, digestive, circulatory, generative, and nervous systems of the insectivora, dwelling especially upon the instances of variability of organs not subservient to special habits which this family furnished, and upon the variations to be found in individuals belonging to the same species. Referring to Gratiolits classing the lemurs amongst the insectivora, Dr. Rolleston said that this arrangement might seem to be justified by the fact that the lemurs differed from other quadrumana by their non-possession of the Hippocampus minor, and of an overlapped cerebellum, and by their possession of a large olfactory lobe. In these points, also, the higher apes resembled the human species, whilst differing from the lower members of their own family.—Professor WILLIAMSON said that in the paper just read there was given an instance of patient, unobtrusive, and important research, of a kind which was not generally recognised by the public. If any one, from a fragment of bone attempted to build up some gigantic animal that existed thousands of years ago, the public flocked to hear and applaud. When the results of such minute, cautious, skilful, and yet learned researches as Professor Rolleston's were put upon record, it often happened that being put perhaps into a more popular form, some one thus ran away with the credit which was really not due to him, but to the original investigator. He never could see or believe in the perfect co-ordination of organs upon which the process of building up the forms of extinct animals was carried on; and Professor Rolleston's paper added several to the existing instances showing that such a co-ordination could not be relied upon.

SECTION E.—GEOGRAPHY & ETHNOLOGY.

In this section, the meeting of which was held in the lecture hall of the Mechanics' Institution, David-street, Sir EDWARD BELCHER presided during the reading of the first paper.

THE ANTIQUITY OF MAN, FROM THE EVIDENCE OF LANGUAGE.

Mr. J. CRAUFURD, president of the section, read a paper on this subject. He said that the periods usually assigned for man's first appearance on earth necessarily dated only from the time when he had already attained such an amount of civilisation as to enable him to frame some kind of record of his own career, and took no account of the many ages which must have transpired before he could have attained that power. Among the many facts which attested the high antiquity of man was the formation of language. Language was not innate, but adventitious—a mere acquirement, having its origin in the superiority of the human understanding. The prodigious number of languages which existed was one proof that language was not innate, some with a very narrow range of articulate sounds, others with a very wide one; some confined to single syllables, and others had many; some being very simple and others of a very complex structure, thus implying that each tongue was a separate and distinct creation, or that each horde formed its own independent tongue. A whole nation might lose its original tongue, and in its stead adopt any foreign one. The language which was the vernacular one of the Jews 3,000 years ago, had ceased to be so for above 2,000 years, and the descendants of those who spoke it were now speaking an infinity of foreign tongues—sometimes European and sometimes Asiatic. Languages derived from a single tongue of Italy had superseded the many native languages which were once spoken in Spain, in France, and in Italy itself. A language of German origin had nearly displaced, not only all the native languages of Britain and Ireland, but the numerous ones of a large portion of America. Some eight millions of negroes were planted in the New World, whose forefathers spoke many African tongues, which tongues had nearly disappeared, having been supplanted by idioms derived from the German and Latin languages. It necessarily followed that man, when he first appeared upon earth, was destitute of language. Each separate tribe formed its own language; and there could be no doubt that in each case the framers were arrant savages, which was proved by the fact that the rudest tribes ever discovered had already completed the task of forming a perfect language. The first rudiments of language must have consisted of a few articulate sounds in the attempts made by the speechless but social savages to make their wants and wishes known to each other; and from those first efforts to the time in which language had attained the completeness which they found it to have reached among the rudest tribes ever known to us, countless ages must be presumed to have elapsed. The Egyptians must have attained a large measure of civilisation before they had invented symbolic or phonetic printing, and yet these were found in the most ancient of their monuments. Dr. Adam Smith divided all languages into two classes, complex and simple, the complex being considered the primary form of all languages, and the simple but derivations, the products of the intermixture of nations speaking different tongues, and striving to make themselves intelligible to each other. In this case, one tongue would be adopted; and, to make it easy of mutual use, it would be stripped of its inflections, easy prepositions, &c. being substituted for them. It was certain, however, that the principle could not be of universal or even general application, and that there were many languages of simple structure just as primitive as those of complex formation. One language might receive even a considerable infusion of another without undergoing any change of structure. There were cases in which, from several causes, even the conquest of one people by another, and the long possession of the conquered territory, might produce no change in the structure of language. In some cases the invaders might be so overwhelming as to be able to supplant the language of the conquered by their own, without the latter undergoing any change. In this way the Saxons substituted their own language for the native idioms of Britain, that language not losing its inflections until it afterwards came to be intermixed with the speech of a new set of conquerors. The substitution of languages of Europe for those of the New World was a case of the same description—even a stronger one. It was quite certain, however, that many languages existed which never could have been formed by inflections. It appeared that the structural character which languages originally assumed would in a great measure depend on the whim or fancy of the first rude founders. No doubt there were facts in reference both to pronunciation and structure very difficult to account for, and which might possibly have some relation to physical differences of races. No monosyllabic language, whether in the Old or New World, seemed ever to have existed west of the nations whom we called Hindu-Chinese. Consonants, and especially gutturals, and other rough sounds, abounded in the languages of North Europe. The structure of the ancient languages of Europe, and, perhaps, of Central Asia, appeared to have been formed by inflections, while the Malayan and Polynesian tongues were invariably of very simple structure. The American tongues, even the language of the Esquimaux, were formed by agglutination—the combining in one word an aggregation of several words—often to the formation of a word comprising the meaning of an entire sentence. Adam Smith supposed, and he (Mr. Craufurd) thought justly, that the first attempts to form language would consist in giving names to familiar objects; that was, in forming nouns substantive. Words expressing quality would naturally be of later invention. Verbs, or words expressing affirmation, must (according to the writer he had quoted)

have been nearly coeval with nouns themselves, since, without them nothing could be affirmed; and pronouns were not likely to have existed at all in the earlier period of language. The same author said that number, considered in general, without relation to any particular set of objects numbered, was one of the most abstract and metaphysical ideas which the mind of man was capable of forming, and consequently was not an idea which "would readily occur to rude mortals who were just beginning to form a language." The truth of this view was corroborated by our observation of rude languages, in which the process seemed to be going on. Among the Australian tribes "two," or a pair, made the extent of their numerals. Some other tribes had advanced to count as far as "five" and "ten." The Malayan nation had native numerals extending to a thousand, above which they borrowed from the Sanscrit. The rude and imperfect numerals of some tribes would seem to have been superseded by the more comprehensive ones of more advanced nations, a remarkable example of which was the general prevalence of the Malayan numerals among all the nations of the Malayan and Philippine Archipelagoes, among the tribes, whether fair or negro, of the islands of the Pacific, and even among the negroes of Madagascar. The Roman numerals had been adopted, to the supercession of their own, by the Celtic nations. The two hands and the ten fingers seemed to have been the main aids to the formation of the abstractions which Adam Smith considered so subtle. This would account for the numeral scale being sometimes found binery, sometimes quinery, but generally decimal. However great the difficulties of constructing languages, there was no doubt they were conquered by mere savages. Language was even brought to perfection as to structure, and for the expression of ordinary ideas, by men who were but barbarians. The poems of Homer, composed before the invention of letters, were as perfect Greek as any that was ever after written. The Sanscrit language, in all its complexity and perfection of structure, was spoken and written at least three thousand years ago by men who, compared with their posterity, were completely barbarian. The Esquimaux had a language of great complexity and structure. Languages, then, were formed everywhere by rude savages, and time alone seemed to have been sufficient to enable them to elaborate a system perfect for its purpose with every race of man. The vocabulary of the rudest tongue probably embraced not fewer than 10,000 words, every one of which had to be invented. These words, in order to form a coherent system, had often to undergo modifications of form, and some of them, besides their literal meaning, had to receive metaphorical ones. What ages, then, must not have elapsed from the first attempts to assign names to a few familiar objects, to that in which language had attained the completion at which it had arrived, as we find it even among cannibals? Between the completion in question and the discovery of the art of writing, made only here and there, under very favourable conditions as to race and locality, how many additional ages must not have transpired? That discovery implied an advanced civilisation, the fruit of very long time. If we considered the introduction of the art of writing among the Jews, for example, to have been coeval with the Pentateuch, this alone would carry us back in the history of language for near 3,500 years, according to the usual computation. But at the time at which the Pentateuch was written, the contemporary Egyptians were a far more civilised people than the Jews, and had been long in possession of the art of writing. He thought the conclusion was inevitable that the birth of man was of vast antiquity. He came into the world without language, and in every case had to achieve the arduous and tedious task of constructing speech, which, in the rudest form in which it was now found, must have taken many thousands of years to accomplish.

Mr. Greswell thought that although the theory advanced by the learned chairman of the section might be ideally perfect and theoretically incontrovertible, there was not a particle of truth in the whole theory. Instead of the term advancement which had been used in the paper, he would substitute the works degradation and deterioration. They believed that the first created man was perfect. Could any one suppose that our first parents had not the means of communicating as rational creatures? He considered that language was not given naturally, but supernaturally, and formed a part of man's creation. There were various arguments which showed that a very few thousands of years measured the time of the existence of man. Homer was supposed to have existed about 1,000 years before Christ, and the most perfect form of language ever used was the Greek; and therefore to speak of him and his contemporaries as barbarians was most absurd. There were also as perfect productions in the Hebrew as in any language whatever. Therefore, to suppose language went on uniformly, and that the antiquity of man could be calculated by observation of the changes of languages, was in his opinion altogether a fallacy, the truth being that instead of advancing language had changed in the way of degradation. The question of inventing a language was something totally different.—Dr. Hincks had been startled by the remarks of the President. It had fallen to his (the speaker) lot, to study a good deal, very ancient languages and the conclusion he had come to was the very reverse of what Mr. Craufurd had drawn from modern languages. Mr. Craufurd appeared to think that all those languages had had independent origins—that every tribe of barbarians invented a language for itself. Looking back to all the most ancient languages he (Dr. Hincks) found that although there were marked differences, which rendered them utterly unintelligible to one another, there were points in common which, when fairly examined, proved that those languages had all a common origin. The people separated—were divided; some parts of the ancient language survived in one portion, some in another, and so on. None of the languages retained even any very large part of the original, but each, probably, sufficient to identify it as part of one original language. As a proof of this he remarked that a brick which had been discovered in Babylonia contained the name of the very oldest King, and also that of the Belshazzar of Scripture, the very latest mentioned of the Babylonian Sovereigns, the inscription being stated to have been made by the father of the latter.—Mr. Leo Grindon did not think it was necessary that they should adopt either of the hypotheses proposed. A very small amount of language would be required in the earliest days of the existence of our race. It would merely be necessary to determine a few forms, and the language would be gradually built up, increasing and improving year by year.—The Rev. J. C. Ebden also dissented from Mr. Craufurd, and asked how it was that those savages first appeared before them possessed of languages which had reached the marvellous development of the Sanscrit.—Mr. O'Callaghan quoted a statement to the effect that tribes of Southern Africans had been known to migrate to another part of that country, and had subsequently been found speaking a totally different language.—General Chesney remarked that the Archbishop of Dublin had strongly taken up the ground that man had gradually declined; that he was originally perfect, and that there was no instance of a savage race raising itself to civilisation. He (the speaker) scarcely wished to go to that extent, but thought they might all go to the belief that man was made perfect, and that up to the time of the flood he might have declined, and probably did, rather than gain in knowledge. The Arabic, however, was spoken in the days of Abraham, and was much older than the Hebrew.—A few remarks were made by Mr. Hebden and Mr. Molesworth.—The Rev. J. H. Kigg spoke of the improbability of the statement that language had been invented by those who were previously an inferior grade of creatures, destitute of speech, and argued that facts pointed to some higher source than merely a natural one.—Professor Wilson agreed with Mr. Craufurd that language was no true criterion with regard to the origin of a race. It might show when a certain people had been, or that they had intercourse with others, but did not prove origin. The

Jews learned Chaldee in Babylon, but were not Chaldeans. Mr. ROBERT CHAMBERS was not aware of any passage of Scripture which said that the power of language was miraculously inspired into the human race. Language was in the course of being made every day. He thought that though the author had assumed too much, the paper on the whole was a sound one.—The Rev. HAMILTON GRAY believed that language had been the gift of God to man. Professor HALL was of the same opinion. How that gift was made, he added, they had different opinions. One thing was clear, He had given us the power of making language for ourselves, of which some excellent examples had been mentioned. He thought, however, the question was one rather for the geologist than the philologist.—Mr. CRAUFURD made some observations in reply, after which he took the chair.

A JOURNEY IN JAPAN, AND ASCENT OF FUSIYAMA.

Mr. J. KINGSLEY, one of the secretaries of the section, read extracts from a paper by Rutherford Alcock, Esq. H.B.M. minister in Japan, entitled "A Journey in the Interior of Japan, with the Ascent of Fusiyama." The paper commenced with a description of the difficulties which the writer encountered in Jeddo, in the early part of his journey in Japan. A large retinue accompanied him. The journey was begun in September, 1860. On their way they had to cross the river Saki on the shoulders of porters, who were made responsible for the safety of the passengers; if any accident occurred to the travellers, the men had nothing to do but to drown themselves, as no excuse was taken. At first their way up the mountain lay through waving fields of corn, succeeded by a belt of high rank grass. Soon, however, they entered the margin of the wood which surrounded the base, and which crept high up the side of the mountain. At first they found trees of large growth—goodly timber of the oak, the pine, and the beech. At Hachimondo they left their horses and the last trace of permanent habitations and the haunts of men. Soon after the wood became thinner and more stunted in growth, while the cork and birch took the place of the oak and the pine. Just before they entered the forest-ground a lark rose on the wing—the first the author had ever seen or heard in Japan. As a general rule, the birds had no song, the flowers no fragrance, and fruit and vegetables no savour or delicacy. In the wood-belt were deer, wild boars, and horses. They soon afterwards lost all traces of life, vegetable or animal. On their journey they rested a little in huts or caves, partly dug out of the side and roofed. There were eleven of these resting places, which were one or two miles apart, between Hachimondo and the summit of the mountain. The latter half of the journey was the most arduous. On the top of the mountain was a yawning crater—a great oval opening with jagged lips, estimated at about 1,100 yards in length, with a mean width of 600, and about 350 in depth. Looking from the mountain, the country below was hid by a canopy of clouds. The estimated height of the edge of the crater above the level of the sea was 13,977ft. and the highest peak 14,177ft. The Japanese, who performed the pilgrimage, were generally dressed in white vestments, which on the summit were stamped with various seals and images by the priests located there during the season. As far as the writer could learn, a very holy man, the founder of the Sintoo religion, took up his residence on the mountain, and his spirit was still held to have influence to bestow health and other blessings on those who made the pilgrimage. The volcano had long been extinct. The latest eruption recorded was in 1707; and the tradition was that the mountain itself rose in a single night from the bowels of the earth, a lake of equal dimensions appearing the same hour at Miaco. The time occupied by the ascent of the mountain was eight hours, and the descent was accomplished in little more than three hours. The party slept two nights on the mountain, and had greatly to congratulate themselves on the weather. The writer remarked that the discontent amongst the people, and the general dearness of provisions, which the government of Japan stated to be prevalent in consequence of the treaty with England, was, so far as his observation went, quite unfounded.

A paper, announced to be read by Dr. Call, "On the antiquity of the Aryan languages," was withdrawn; and one by Dr. R. Wollaston, "On some account of the Romans in Britain," was deferred.

THE SPITZBERGEN CURRENT, AND ACTIVE AND EXTINCT GLACIERS IN SOUTH GREENLAND.

Colonel SHAFFNER (United States) read a paper on the above subjects. In June, 1777, ten whaling vessels were beset in the ice about lat. 76 deg. north, between Spitzbergen and Jan Mayen. They endeavoured in vain to escape, were carried by the ice in a south-western direction between Iceland and Greenland, and by degrees the vessels were all lost; only 116 of the 450 men who composed the crews escaping, they having reached the South Greenland coast. Little was known of the loss of these vessels, but it might be supposed that the floe ice was not compact, and that they were chafed until their hulls were worn, so as to permit the water to enter them. On the 22d of June, 1827, Captain Parry started on a boat expedition from Spitzbergen towards the North Pole—one of the most hazardous efforts known in Arctic annals; but he was obliged to put back on the 24th of the following month, and return to his ship at Spitzbergen, the drift or current having carried him 14 miles to the southward in the last two days of the journey. South of Spitzbergen and Jan Mayen the ice sometimes spread and came south upon North Iceland, the gales north of Iceland and south of Spitzbergen spreading the ice in detached pieces or small bergs eastward, from 100 to 200 miles from the current track, which runs southward along the Greenland coast. Directly west of Iceland, the floe ice had seldom been seen from the highest mountains. South of Iceland, the ice floe was in the direction of Cape Farewell. Timber was often found drifting near the east and west coasts of Greenland. The width of the Greenland current did not, in his (Col. Shaffner's) opinion, exceed 50 miles; it carried with it floe ice and berg ice. It was not known but that much of the floe ice came from the icy seas north of Russia. The year 1860 was remarkable for the great quantity of ice brought by the Greenland current, and added to that brought south by the Baffin's Bay and other currents of Davis Strait, produced the unusual dangers experienced in navigation from America to Europe in 1861. More ice had been seen in the usual track of the steamers during this year than at any previous period. This was to be expected after the reports from the Bulldog and Fox expeditions of 1860. Captains of vessels from Greenland reported that there had been but little ice in the Greenland current this year; and it might be expected that navigation between America and Europe would be but little hindered by the ice in 1862. When north-east winds blew the coast was free from ice; a west wind drove the ice upon the coast. It might be safe to estimate the velocity of the Greenland current at ten nautical miles per hour from north of Spitzbergen and Cape Farewell, and then northward to about latitude 64 deg. north, where it began to spread and join with the northern or Baffin's Bay current. The length of this current being about 1,600 nautical miles, and supposing its width to be 50 miles during four months of the year, they might estimate the decay of ice from 75,000 to 80,000 square miles, within the tract of the Greenland current. On the subject of glaciers, the Colonel expressed his opinion that the "Igalikko" was once an ice fiord, that the glacier extended where water was now seen, the water reaching even more into the interior than the edge of the present glacier—the moving of the ice having ground up the rocks, and the earth and the small particles gradually filling up the fiord. The supposed ice area of Greenland being about 400,000 square miles, such an area ought, if all of it were ice, to give off more upon the known coast than was seen. It was reasonable to doubt the existence of such an extentl of ice. There might be less fall of water than was common to like latitudes, and there was no means of

allowing for the melting by the sun. The ice from the interior was forced down into the fiords, the water in some degree bearing up the ice until there was a projection to such an extent that the ice broke off and fell into the water, with a crash that might be heard several miles. The detached piece then became an iceberg, and lay in the fiord until it was carried out by the wind and tide. These fiords were some thirty miles from the sea. The berg was being reduced in size by the action of the frost, the wind, and the sun, from the moment it broke from the glacier. In the interior the ice was a plateau; and there were not many crevasses.

CAPTAIN PARKER SNOW ON ARCTIC EXPLORATIONS.

The following is an abstract of a paper read by Captain PARKER SNOW, "On the geographical science of Arctic explorations, and the advantages of continuing it."—The marvels connected with Arctic explorations are so many and so great that something more than second-hand statements is required to make them credited. Personal experience, or reference to positive facts, becomes necessary for the verification of what is said. My object in this paper is to bring forward some of those facts, gathered from my own experience and the greater experience of others. It is also to show that, though the dangers of Arctic explorations are undoubtedly great, they are not more so than in other parts of the world now under exploration; nor are they such as to deter us from persevering in that glorious work of investigation which has made England so famed throughout all the globe. Objections have been made as to the utility of Arctic explorations; but I at once reply to such, by saying that, were my purpose mere argument instead of fact, I could prove the great advantage gained by our labours in the North. As it is, let me only refer to the recent great results of the American whale fishery in parts opened out by our navigators through Behring's Straits; and also let me point to our gallant naval officers, whose several expeditions have tended so much to the honour and glory of our flag. Let me briefly explain to you how the North-west Passage came to be proved a fact. This was shown by the labours of not merely one, but many explorers; the priority of completing the last link, however, undoubtedly belonging to Franklin and his unfortunate companions. A water passage along the Arctic coast of America was found, and a communication from Parry's route higher north was effected, and thus the link was complete. The other route, from the west, along which M'Clure carried our flag, is one that has not yet been found as a water communication. It is well known that I tried hard to get away in my vessel in the past summer. I was, however, too late before I could get fully equipped, and, by the advice of those supporting the expedition, I have reluctantly delayed till the next season.—Captain Snow then described the nature of the localities visited by the several expeditions, the formation of ice, its immense masses, the difficulty of navigating through it, and the more than ordinary skill required. Refraction, terrestrial magnetism, long daylight in summer, and equal duration of darkness in winter, with the various phenomena and the animals of the Arctic seas, were also alluded to, and the methods adopted by the voyagers to guard against the cold and to maintain health. The science shown and gathered in the expeditions, and the advantage to us, as a commercial nation, were ably shown, and the Captain, in conclusion, said:—This proof of the soundness of geographical science was that which all ages had shown. It was that which enabled Columbus to say to those of his day,—There, there in yon dark and mysterious west is another and a mighty world, equal to your own. It is that true germ of science, budding and growing in man's mind, which enables the unknown, the humble, the ill-clad labourer to mount on high beyond all common things, and in a short time to burst upon the world with new light on some valuable and important subject. Here, surrounded by eminent travellers and numerous intellectual minds, who must have felt all this, I need say no more on the subject. But I must now ask, Why should the Arctic regions be forbidden to the energy and the perseverance of man? The Swedes have sent a good expedition towards the North Pole; the American has gone there; and why, then, are we to stop, after so many years of glorious labour? Mineral wealth is found in those regions; the fur trade can be well extended; the whale fishery improved, and, above all, the honour and dignity of our flag maintained by completing that little yet remaining to be accomplished in the polar seas. I would venture to suggest that Government should be asked to send a ship to the Mackenzie for magnetic purposes, and to collect those scientific documents undoubtedly left by the ill-fated Franklin expedition. Everywhere England is nobly at work spreading and obtaining new light. She stops nowhere, save just now in that very region where she has so long laboured. Hand to hand the Saxon and the Gaul, the white man and the black, are traversing the earth in all directions seeking to gain new intellectual wealth and to benefit each other. The native races are becoming better known, and their rights more respected. And thus, in the east, the west, the south, and yet the north, will pure light be spread and the knowledge of sound truth disseminated. It is by such great and daring deeds as those I have dwelt upon that a nation wins its fame. Geographically, our country is but a speck on the surface of the globe; and yet how great, how mighty she is! No difficulties, no dangers appal her, and she pursues her way, undisturbed at home, while storms and convulsions often reign elsewhere. So England advances; so England will advance, whilst England's sons, encouraged by England's fair daughters, boldly carry our time-honoured flag, here, there, everywhere—aye, even to the very pole itself.

The several gentlemen who had read communications received the thanks of the section, the proceedings of which terminated about four o'clock.

SECTION F.—ECONOMIC SCIENCE AND STATISTICS.

Mr. V. NEWMARCH, F.R.S. the president of the Association, on taking his seat, announced that the business of the day would consist chiefly of papers on taxation, and on the question of the income tax. A discussion would be taken on these papers after the whole had been read. The chair having been temporarily taken by Mr. Tite, M.P. Mr. NEWMARCH proceeded to deliver an address on the extent to which sound principles of taxation are embodied in the legislation of the United Kingdom. As regarded taxation in a free country, they might lay down two fundamental canons: First, a willingness to bear whatever taxes were required to advance the honour and liberty, and to secure the safety of a State; and secondly, there should be a readiness to devise and boldness to advocate these burdens. There were three fundamental divisions which appeared to him exceedingly important to be borne in mind. The first was the amount, large or small, of real revenue to be raised; second, the extent of the population, large or small. who had that revenue to raise; and third, the nature and variety of the resources of the population which had to raise that revenue. He referred to these conditions at the outset, because he thought they should find as they proceeded it was most important to bear constantly in mind the broad differences of various countries as regarded the system of taxation. There was a great difference, for instance, between a country like our own, where the great mass of the population were dependent upon wages earned from trades of the most varied kind, and a country like France, where the great mass of the population were dependent upon the occupation of land, that land to a great extent being their own property. There was a very broad and marked distinction between the two cases; for a system of taxation which might be wise and prudent as regarded ourselves would not be a good system as regarded France, and *vice*

vered. In the course of the discussions which have gone on for a long period upon the question of taxation they might say with considerable truth, that there were three leading theories which had been put forth at various times, and by men of various degrees of eminence. It had been contended, for example, that all taxes should be levied on the principle of assessing every person in proportion to the amount of protection he received from the State; that opinion had many supporters. The second was, that all taxes should be arranged and levied on the principle of taking the largest proportion of payments from those persons who had the largest income, and therefore that the rates of annual assessment should be progressive according to the amount of annual income, being for example, one per cent for £100; five per cent, and so on. The third might be stated in this form—that all taxes should be arranged and levied on the principle, of excepting labour and skill, and placing the burdens wholly on realised property; for example, the profits of the stock in trade of a merchant, or a dealer should be free; but the realised property of the fundholder or the landlord should be assessed. These two opinions represented to a large extent the different views which had been maintained from time to time as regarded the true foundations of the fiscal system. He was bound to tell them that so far as he could judge, none of these would carry them very far in solving the difficulties they had to encounter. As to paying in proportion to the protection afforded by the State, they would very soon find themselves arrested by a class of cases with which, he believed, they could not deal. Protection must be measured either upon the basis of what a man saved or upon the basis of what a man spent. Take the basis of what a man spent. Take as a period ten years. Supposing in that period, A, from some source or another, earned £1,000 a year and spent the whole of it. B got £1,000 a year and saved £900. C in the course of ten years consumed year by year £1,000 out of a capital of £10,000. If the system of taxation were adopted by which each was assessed according to what he spent, they should have to contend with this difficulty:—In the first year B would pay one-tenth as much as A, and would receive ten times as much protection. In the second year he would pay one-tenth as much and have 20 times as much protection. On the other hand, C would pay each year ten times as much as B, and at the end of ten years would be a beggar; while B at the same time would have amassed a fortune. That would be the kind of thing which would come to pass if they estimated according to what a man spent; because when they were asked to found a fiscal system upon the principle of the protection received they must be prepared to carry it out arithmetically, and apply to it the ordinary machinery of the tax-gatherer. Take the other hypothetical measure of protection, and assess it accordingly, to what a man saves. A spends the whole of his income. A thus possesses premises ten times larger than B, but pays no taxes because he saves nothing; while B, who spent only £100, paid ten times more than A because he had nine times more accumulated wealth. C was worse off than A, because in ten years with the same expenditure his income would wholly cease. So far for the founding of all taxes upon the measure of protection afforded. Take the second hypothetical plan, that of taxing a man in proportion to the increase of his property he possessed. This seemed to him the most objectionable and hazardous of the schemes which had been suggested as the basis of fixed legislation, insomuch as it discouraged the man who was virtuous and frugal, and conferring the greatest possible benefit by adding from year to year to the accumulated wealth of the country. Beyond that there was this principle—and it was a principle which lay so near the whole of this discussion that he hoped the section would bear it in mind—it was no part of the business of the legislature to interfere with varieties of personal fortune. Whether a man was rich or poor—whether he was eminent or lived in obscurity—these circumstances were regulated by a higher power, and were circumstances which a wise legislature would not do more than recognise, but would not interfere with. Then came the plan of placing the whole taxation of the country on realised property. That again was the opinion which appeared to him to be subversive of some of the most fundamental rules which applied to society. In a great mass of cases the property people possessed had been fairly earned, and he confessed so far that he had not heard, and he should be very much surprised if he did hear any valid reason why the whole expense of conducting the affairs of the community should be borne by a class of that sort. Passing over these hypothetical canons of taxation, let them see, let them look at those which had stood the test of experience—those propounded in the "Wealth of Nations," and which since the appearance of that book had been carried more or less into all civilised communities, and had received the sanction of many eminent persons. Shortly, the four fundamental canons of taxation laid down by Adam Smith were these:—1. That all persons should contribute in proportion to their respective ability. 2. That the assessment should be separated in amount and the liability thereto clearly defined. 3. All taxes should be levied at a time and in a manner most convenient to the payer. 4. That the tax should take out and keep out of the pocket of the payer the smallest possible sum. How far did the actual legislation of this country carry out these four classical canons of taxation? In 1860 the total imperial revenue was 70 millions sterling. He had divided this into two separate categories. In the first he had brought together all the taxes which fell below interference with industry, enterprise, and skill; and in the second he had brought together all those taxes which, more or less, did interfere with industry, enterprise, and skill. The total of the first category was 37½ millions, and the total of the second 33½ millions. If he could convince them that this was a fair exhibition of the existing taxes, he submitted that he should have advanced no small way towards satisfying their minds that in their actual legislation they had succeeded, to the extent of nearly 60 per cent, in reducing to actual practice those classical canons of taxation. In the first category—those taxes which did not interfere with industry, enterprise, or skill. A revenue of something more than nine millions was derived, under the head of customs, from taxes on extravagance — spirits, tobacco, wine, &c. These, by the general admission of financial writers, were regarded as the fairest subjects of taxation; some of them being matters of superfluity and extravagance, and some, objects of consumption which it was not desirable to extend. The two and one third millions duty on spirits was a kind of revenue which none of them would like to see diminished; and, on the other hand, the revenue could not be increased without leading to the greater evil of smuggling and illicit distillation. He should be glad to see—not two, but five millions raised from this source. They had not only nine millions under the head of customs, but, under the head excise, they had twelve millions more from spirits; and they got from malt, altogether, nearly £6,800,000. He had put down one-half of this as not interfering with the second category. The result of this compartment of the table was, that they derived from taxes on extravagance, £25,000,000 a year, or more than one third part of the total revenue. In the second place, there were taxes which might be described as wholly enormous; such as the customs' duty on corn; the railway duty, and the Post-office, from which they derived three millions and a half. Then there were deeds, taxes on transfers of property eight millions, and half the duty on fire insurance one and a half millions. He had made up the total 37½ millions, which was something like sixty per cent on the total revenue of the United Kingdom, derived entirely from sources which fell below the line of interference with industry, enterprise, and skill. Let them now go to the other side of the picture, which was not quite so satisfactory—the taxes which did interfere with industry enterprise, and skill

There were first, moderate taxes on general comforts,—tea, coffee, and sugar—thirteen millions. He had called these moderate taxes on general comforts, as contradistinguished to excessive; and he submitted that the whole of the thirteen millions must be regarded as a species of indirect taxation, which fulfilled almost entirely the conditions of a good indirect tax. They heard a great deal about the unmitigated evils of indirect taxation. A really good indirect tax was a tax which involved the least interference with trade, and was derived in such a way as not to infringe the canons he had referred to. Then there were assessed taxes, license taxes, &c. producing altogether four millions. He should very much like to see that four millions very much reduced, or knocked off altogether. He did not see that the license duties were the best form of raising revenue. He was willing to admit that as regarded a considerable part of that four millions it did interfere to some extent with industry, enterprise, and skill. The tax on paper was a tax last year, but was now no longer a tax.—(Hear, hear.) It was happily repealed; and he rejoiced as much as any one at its abolition. It was a tax which sinned against nearly all the conditions of fiscal regulations. As regards the duty on hops, which amounted to £800,000, he hoped it would be got rid of at the earliest possible period. He had not a word to say in defence of the tax upon hops. Half the malt duty and half the duty on fire insurances he had also put down in this category. He was glad that the paper duty had been repealed; he joined heartily in the condemnation of the hop duty; he entertained a fervent hope that the day was not far distant when the tax on licences would be repealed, and the duty on malt and on fire insurances would be modified; but making all these allowances, nine million was the very outside of the amount of taxes actually raised last year, which could be said to interfere in any large manner with industry, enterprise, or skill; and he submitted that he was justified in saying that up to the present time they had succeeded in this country in introducing to a very large extent, and with eminent success, those four classes of principles of taxation which he stated at the outset. He admitted that 30 years ago when the revision of their system of taxation began, it was so imperfect and so full of mischief that denunciations of the strongest kind were justifiable. But the labours of thirty years had been an incessant approach to the removal of these defects. They were justified in arriving at four conclusions. Bearing in mind that they had to raise a total in this country of nearly seventy millions—that was excluding the local taxation of the country, which he might put put down as twenty millions more; bearing in mind that they had to raise this revenue from thirty millions of people, the great mass of whom were engaged in industrial occupations, he thought they were justified in concluding that the actual system of taxation now in operation was eminently in accordance with the genius of the country, with the commercial and industrial condition of the inhabitants; and, judging from past results, the system had been eminently successful, and had produced no small share of contentment throughout every part of the Queen's dominions. Carrying with them these conditions as well and distinctly as they could be taught, they were justified in coming to the following four conclusions:—1. That a very large part of the permanent imperial revenue of the United Kingdom, a part certainly exceeding one half was raised from taxes not open to serious objection, abstract or practical. 2. That in an old country in which 90 millions sterling total revenue, imperial and local, had to be raised from 30 millions of people, the great mass of whom subsisted on wages, indirect taxation to a large extent was inevitable, and might be so adjusted as not to render it an evil. 3. That direct taxation, which was virtually an assessment on income, already amounting in the present year to 8 per cent, would not admit of extension. 4. That a suppression of any large part of the present indirect taxation on articles generally used would render necessary heavy poll tax or a tax on small incomes, which were both in a high degree impossible. The present system was not open to the sweeping censures, and certainly was not susceptible of the subversive changes, which in some quarters had been lately recommended. In the matter of taxation, there was no room for sentiment. Justice to all classes alike, and economical fitness was what they had to regard, and it was because they had done this during the last thirty years that they had brought their system to the satisfactory condition in which they found it at present.—(Cheers).

Professor ROGERS, read a paper entitled "Taxation, its definition and its incidence." The rev. gentleman defined a tax to be a contribution imposed by an acknowledged authority, on a community for the purpose of public utility, whether this utility was the discharge of obligations incurred for past services, or for the maintenance of present capacities of production, the tax being levied on the ground that the utility procured, service rendered, or functions performed by the administration of this contribution cannot possibly be procured, rendered, or performed by individuals, or by inferior co-operative agencies, or cannot be so economically discharged by them. The incidence of a tax was as follows:—If a tax be levied on sources of income which are of an elastic character, that is on the services of productive labour, it must be paid by the consumer, and though such an incidence might be inexpedient to the community, it is not unjust to the person who is the channel of the tax. But if it be levied on income, which is not elastic, it may be unjust to the latter—that is, the person who pays—as well as inexpedient to the person or persons who represent the consumer. Abstractedly there can be no doubt about the fact, that on the hypothesis of its being collected, there must, on economical grounds, be a preference of direct over indirect taxation. But political and moral causes stand in the way of a practical conclusion in favour of the former method. If a tax be permanent, uniform, and levied on all persons engaged in the same occupation with equal exactness, I cannot see how it can fail being thrown on the consumer. But such an incidence is not so in point of fact. No doubt there are many persons in class X, commission agents or brokers, who understate their profits. There are some who make a just return. And on ordinary economical grounds, if this class X were not taxed at all, matters would soon reach their own level and the charge of a broker's or commission agent's services would fall accordingly. But if, as is doubtless the case, six out of ten in class X make a true return, and the other four make a false or no return, the tax is economically unfair. I know no remedy to such a contingency save a moral education, and a sense of public duty far higher than has hitherto been experienced, or even hoped for. And herein lies the very weakness of arguments about the desirability of direct taxation. The practice is surrounded with such enormous moral difficulties that its present position is unjust, its extension intolerable, and its moral effects mischievous in the highest degree. It is not in the fact that permanent and precarious incomes are equally taxed that the evil incidence is felt, but in the accidental or fraudulent emancipation of individuals in the same class with those whose profits are liable to this deduction.

Mr. J. R. JEFFERY (Liverpool), for Mr. M'Queen, read a paper on the "True principles of taxation." The following is an extract:—As the basis of the discussion, we would lay down the substance of the rules or principles of taxation, which have been propounded, or recognised by the most eminent political economists of these, and other days, and which appear to us to be, not merely irrefutable, but placed beyond the possibility of rational objection. They may be thus epitomised:—1. Every subject ought to contribute equally towards the due support of the State—equally, that is, in proportion to his means, and the advantages which he enjoys from State protection. 2. Taxation being the payment of a just debt which every individual owes to the State, it should be levied on some certain scale, and the payment ought not to be arbitrary, voluntary, or capable of evasion, since, i

it be dependent on the will, tastes, inclinations, or conscience of the individual, he is enabled to throw his own share of a just debt to the State upon others. 3. Taxation should be so devised, and so levied, as to take as little as possible out of the pockets of the people beyond what it brings into the public treasury, and to present the smallest possible obstruction to their earnings. Let us see how far the two systems of indirect, and direct taxation, are in conformity with, or in opposition to, these unquestionable propositions. Indirect taxation is chiefly levied, in this country, by means of duties of Customs and Excise, upon commodities, which, though paid by all consumers, must necessarily fall most heavily upon the industrial classes, and the poor, who constitute the great bulk of the community. Those who consume not the articles taxed, avoid the payment of the portion of the debt to the State, in manifest violation of the second rule. The political economists who uphold this system as the most convenient means of providing for the national expenditure, nevertheless maintain that such duties should be levied solely for revenue purposes, contending that the moment they become prohibitive, or even protective, that moment their legitimate object is frustrated, since their tendency is then to decrease the revenue, instead of increasing it, and by diminishing consumption and production, to strike a deadly blow at the very foundation of national greatness and prosperity, in a commercial and manufacturing country such as ours—freedom of trade. But who will venture to say that the scale of duties in our present tariff, greatly reformed as it has been of late, is one wisely calculated for revenue purposes only, and inflicts no restrictions on commerce, manufactures, and trade? Referring to the duty on tea, the paper proceeded to say: What sources of poverty, misery, vice, and crime would be removed if the working classes of this country were only placed on a level with our colonists in that one article of tea! In Australia, before the gold discoveries, the consumption was estimated at 15 pounds per head per annum. The average consumption in the United Kingdom last year was only 2lb. 9oz. During the last session of Parliament, many honourable members, not hitherto distinguished for their free-trade principles, dilated on the heavy pressure of the tea duty on the industrial classes, and on the great advantages to them and to the trade and shipping of the country which would result from a reduction of the duty by 3d. per lb. All this was undoubtedly true; but if such were the benefits to arise from a reduction of less than one fifth of the duty only, how vastly would they be increased by its total abolition! Coffee, another great civiliser, and potent foe of drunkenness, is taxed as if it were a poison instead of an antidote. That of the lowest quality pays the same duty as the highest, 3d. per lb, and a quarter per cent. The duty operates as a premium on adulteration. To meet this mishief, chicory, its most convenient adulterator, is taxed; and chicory, in its turn, is adulterated also. Thus, one of the most powerful antagonists of the demon drunkenness, is all but banished from those who most need its aid; a wholesome beverage is polluted, and the revenue is robbed and re-robbed through the agency of duties imposed for its benefit. Sugar, also, is heavily burdened, and with the same consequences, — restriction of consumption, limitation of trade and employment, unprofitable abstraction of capital, adulteration, and great injury to the community at large. There can be no doubt that the numerous coffee-houses, first established some years ago, on a partial reduction of the sugar and coffee duties, are successful and most beneficial competitors with public-houses. But how much more powerful would they be if tea, coffee, and sugar were obtainable at their natural prices,—prices which would require no unprofitable investment of the merchants or dealer's capital in customs duties,—the prices of perfect free trade! And how would the domestic comforts be multiplied, with the refreshing cup at any time within the command of any man's or woman's wages,—the cupboards stored with jars, the jars with preserves,—the fruit grown in abundance preserved in sugar which paid no taxes! In the case of sugar an attempt is made to regulate the scale of duties according to quality. It depends on the judgment of the Custom House officer, which may be honest,—may be erroneous unintentionally,—or may be warped by a bribe equal to a whole year's pay, whether the duty paid shall be 18s. 4d. or 12s. 8d. per cwt. The monster evils of the enormous duties on tobacco are the temptations to adulteration and smuggling. Several of the Excise duties, especially those on alcoholic and fermented liquors, are fraught with similar evils, many of the adulterative ingredients employed being of the most deadly mind-and-body-destroying character; and they have others peculiarly their own. So far as can be ascertained from the Government accounts, the charge for collecting the indirect taxes amounts to about 10 per cent. Who can estimate the wealth whose creation it has prevented, — the goods manufactured, — the ships never loaded—never built,—the profits never made,—the wages never earned,—because Customs and Excise Duties forbade the people to consume those articles which foreigners, or native manufacturers, had to sell, and thus prevented them from producing other articles which those foreigners or natives would gladly have taken in exchange? Who can calculate the amount of the losses which have thus unquestionably been sustained? Calculation is here altogether at fault;—but we conceive it to be no extravagant assumption to say that, with perfect freedom of trade and industry, only attainable by the abolition of all Customs and Excise Duties, our gross and annual consumption and production would very speedily be doubled; that the cost of taxation to the public, instead of being, as it now is, nearly, if not quite, half a crown for every shilling that reaches the Exchequer, need not exceed threepence in the pound; and that the wealth created by the removal of existing restrictions on labour and exchange, would enable the country to bear, if necessary, double the weight of our present expenditure, enormous as it is, with far less injury to the community. Is direct taxation,—by which we mean, not the present income, or miscalled property tax, abounding as that does in injustice and anomalies, but a properly-adjusted system, such as statists and actuaries could readily devise,—is direct taxation open to all or any of these objections; and, if to any of them, in a degree at all comparable to its opposite? Most confidently we answer these questions in the negative. By a direct tax only,—that is, by a certain poundage or per centage on capital, income, or wages, can we insure anything like conformity with the first rule,—equality of taxation. To say that perfect equality is unattainable, that under the best devised system there must be some inequality, some injustice, is only to say that perfection is not an attribute of either human nature or human legislation. But that the very worst devised system of direct taxation, even an extension of the present income tax, with all its injustice and anomalies, sufficient to meet the State requirements, would be greatly preferable to any system of indirect taxation, including duties of customs and excise, we hold to be capable of demonstration. The capital stock of the country, or the income from it,—that is the wealth of the country, not its necessities or comforts, which we may call its poverty,—is the proper subject for taxation. This capital stock was lately estimated in the *Edinburgh Review*, by an authority supposed to be official, at 6,000 millions sterling. Others rate it as high as 10,000 or 12,000 millions, and it is not improbable that the highest estimate is nearest the mark. We have to raise this year a revenue of upwards of 70 millions, which is more than ten per cent on an income of 700 millions. Of the various schemes of direct taxation which have been propounded, we shall allude only to three which seem most deserving of attention:—1. The proposition of the author of the "People's Blue Book," which comprises a tax of four shillings in the pound on the annual value of all real property and invested funds yielding rent, interest, or dividend to the owner without his personal exertions; a poll tax of £1 per head on all persons above fourteen

years of age, in consideration of the protection afforded by the State; and the retention of certain existing sources of revenue, other than duties of customs and excise; thus leaving commerce and manufactures, agriculture and industry, entirely free, troubling no man with inquiries as to profits or earnings, tempting no man to fraud and perjury, but taxing every man the moment he invests profits or earnings, as they must be invested, in some species of property, properly subject to taxation. 2. The second plan of direct taxation to which we shall allude is that under which all real and personal property, goods and chattels above the value of £50, excepting stock in trade, would be taxed, to the exclusion of all inquiries as to profits, earnings or wages, but imposing a small poll-tax in addition. This is the plan of taxation adopted in most of the states of North America, for state purposes. 3. The third plan is that recommended in the draft report submitted by the late Joseph Hume to the Income-tax Committee of 1852, of which he was chairman, but not adopted by the Committee, which contented itself with reporting the evidence to Parliament. That plan is based upon the capitalisation of all incomes from whatever source proceeding—property real or personal, professional earnings, profits of trade, or wages of labour, according to the marketable or calculated value—a scheme which, in the opinion of Dr. Farr, and other eminent authorities, examined before the Committee, is perfectly practicable, and presents no difficulties but such as are encountered and overcome by actuaries every day of their lives. By any one of these three plans, equality of taxation might be attained much more nearly than under the present income tax—immeasurably more nearly than by any system of indirect taxation. Under any one of these plans, taxation would be in conformity with the second rule, or, as nearly as possible, an approximation to compliance with its conditions. It is in reference to the third rule that direct taxation presents the most unapproachably superior advantages. As to expense of collection,—the smallest part of the sum taken out of the pockets of the people, beyond what reaches the Exchequer,—whilst the present gross cost of collecting the revenue is little, if anything, short of 10 per cent; we find from the 5th report of the Inland Revenue Commissioners, that the charge for collecting £11,158,883 of income and property tax, for the year ended April 5, 1861, was £201,823, or £1. 16s. 2d. per cent only. In that year the amount of public income, from all sources, was £70,569,998, to which customs and excise duties contributed £42,826,383. The charge of collection and management, exclusive of coast-guard, packet service, pensions, and compensations, was nearly five millions. That sum of £42,800,000 represents the actual amount of capital withdrawn from reproductive employment. To none of these plans,—nor to any other, are we wedded,—but we maintain that, under any one of them, or under any other system of direct taxation, the three conditions of taxation to which we have adverted in the commencement of this paper,—equality, certainty, and economy, would be more nearly attained than they could possibly be by any system of indirect taxation whatsoever. It is for the principle of direct taxation that we contend, being convinced that when once public opinion is sufficiently enlightened to see that it is the principle on which the present amount of revenue, or any other that may be absolutely required, can be raised with greatest benefit to the State, and least injury to the community, the means of carrying it into operation will readily be found. It is for the principle, therefore, that we battle. The arrangement of details we leave to others, and more especially to the Legislature, and the Government, whose province it is to see that no harm that can be avoided comes to the commonwealth,—no good withheld, which is by human means attainable.

Dr. Clarke read a paper on "A revision of the national taxation," in which—taking the income of the country, from all sources, at 642 millions sterling, which he divided into two schedules, in one of which he classed incomes from realised property, and in another profits from trades professions, pensions, salaries, &c.—he advocated a graduated scale of per centage on these incomes, and the retention of the duties on articles of luxury.

The discussion on these papers was commenced by Mr. G. Holland, who said that the reduction of indirect taxation had led to increased consumption, and contended that the President had no right to draw a line and say they were to stop in a course which he himself admitted had been hitherto eminently successful. The question was, whether taxation ought to fall directly upon the property of the country, or to be paid in a circuitous and wasteful manner by indirect means, which interfered with the industry and comfort of the people.

Mr. Wilson said the chairman advocated a reduction of the licence duties. The best system of raising revenue, he thought, would be to extend the licensing system and apply it to every trade. It was as fair for one as the other. Why should not the stationer be taxed in this way as well as the grocer? Why also should it not be allowed to extend in the way of public-houses, and licences be allowed to every one, provided they were respectable persons? This would materially increase the revenue of the country, and in a direct manner.

Mr. Lawrence Heyworth said that 25 years ago, when the foreign trade of the country did not exceed 50 millions, they were obliged to raise a revenue of 5 per cent from customs to meet the expenditure of the country. But that 5 per cent scarcely realised the sum, and Sir R. Peel wisely determined to set the wheels of industry free, in order that money might be made with which to pay the taxes. If they took off the forty millions of indirect taxation, the effect would be to cheapen goods, and to double the consumption. He did not say that the present income tax was the best way of raising a direct tax; but it was infinitely better than custom-house duties, which cut down trade and destroyed the commerce of the country.

Dr. J. Watts said he should confine himself to a criticism of the remarks of the chairman. The chairman contended that the largest portion of the taxation should not be taken from the largest incomes, as that would be to tax frugality. This would not universally apply, inasmuch as a great many landed proprietors got rich while they slept. It seemed to him to be the best possible plan to get the greatest amount out of those whose income was the largest. To tax labour and skill was to tax the energy of the men who produced the wealth rather than to tax wealth when it had been realised; and was like taking the seed out of the ground instead of allowing it to grow and produce grain. He contended that the income tax might be amended so as to render it unobjectionable, and to prevent the frauds which had been complained of.

Mr. W. Horsfall (Garden-street) remarked on the difference between the cost of collecting an indirect tax, which was about 10 per cent, and the collection of a direct tax which amounted to 2 per cent.

Colonel Sykes, Mr. Pankhurst, Mr. Hamblin, and Mr. Raper joined in the discussion; and the President afterwards replied, especially directing his remarks to the scheme of the Liverpool Financial Reform Association, represented by Mr. Jeffery, and condemning the schemes of direct taxation, which, by a sort of sidewind, they indicated as the sort of schemes they would like to see introduced, as not paralleled in oppressiveness, impracticability, and exceptional qualities, even in the Turkish empire.—(Laughter.)

THE INCOME TAX.

The Rev. Canon Richson read a paper "On the income tax." He quoted the report of the late Committee of the House of Commons, in which they declined to interfere with the present mode of levying the tax. The reverend gentleman quoted the instance of a clergyman deriving £150 from a living in a large parish, the extent of which necessitated the employment of two curates. The clergyman gave up the whole of his income towards the payment of his assistants, but both he and they were compelled to pay income tax, though he did not receive a farthing.

The Treasurer of the Corporation received the proceeds of certain estates, which it was his duty to divide in certain proportions among persons interested, after paying the expenses of agency in collection. As the tenants and others deduct the income tax on paying their rents, &c. his total receipts had paid the tax, but the agents whom he pays for assistance out of such receipts and the parties amongst whom he divided the surplus all pay the income tax on the several amounts they so receive. The amount he received, therefore, merely as an agent or instrument to hand over to to others, paid the income tax before it came into his hands, and this same amount was again charged with income tax without the allowance of drawback or return, when it comes into the hands of those whose income it becomes; the same sums, therefore, paid a double tax. Taking into consideration the refusal of the report to recommend any modification of the present acts for levying and collecting the income tax; that the number of persons who suffer unjustly from the operation of the present acts was very large; that there were sufficiently definite objections to their operation in which persons were afraid without involving subjects of discussion in which there was little immediate prospect of agreement; that the operation of the present acts led to habitual frauds injurious to commercial integrity; and, finally, that the efforts of individuals were unequal to the contest which appeared necessary, with the prejudices and interests arrayed against such a revision of the acts as their very terms appeared to justify; he considered that after so unsatisfactory a result of two committees of the House of Commons as was indicated by the present report, it was useless to expect equitable improvement, unless they were prepared for the present to sink their differences of opinion in respect to extensive modification of the bases of the tax, and to form an extensive association, with the restricted and clearly defined object of promoting the application of the Income Tax Acts, in harmony with their declared objects.

A discussion followed, in the course of which the PRESIDENT thanked Canon Richson for his paper, and said that the clergy suffered more than any other class from the inequitable operation of the tax.

SANITARY IMPROVEMENTS.

Mrs. FISON, of Brighton, read an interesting paper, in the course of which she pointed out the moral and physical advantages to be derived from attention to sanitary regulations.

EXCEPTIONAL SOURCES OF COMMERCE AND UNDESIRABLE SOURCES OF REVENUE.

Mr. CHARLES THOMPSON, in a paper on the above subjects, quoted from the budget speech of Mr. Gladstone in April last, which, he said, indicated suffering from a serious scarcity of food. Even in ordinary years, when our own harvest fields produced their usual crops, we were dependent upon foreign supplies for a very large proportion of corn food for man and beast. But when a year of great scarcity, or a series of bad harvests befel us, we found our monetary arrangements upset, and our commerce fearfully depressed. Mr. Gladstone's statements also indicated that an increased revenue from corn occasioned by an enormous increase of importation, to meet great domestic scarcity was an evil element, inasmuch as it crippled and limited the power of the people to adequately sustain the fiscal burdens of the country. In other words, Mr. Gladstone intimated that he had been a sufferer in regard to his fiscal arrangements, by the increased revenue of £366,000 he last year received from duty on corn, over and above the sum of £500,000 which he took to represent the average revenue from that source. This arose partly from the fact that there were other articles more highly taxed than corn, which was imported at the nominal duty of 1s. per quarter. A Chancellor of the Exchequer could not have overlooked the fact that nearly eight million quarters of grain are annually consumed in brewing and distilling in the United Kingdom. This calculation took no cognizance of what is appropriated by illicit manufacture either of malt or spirits, or in the legal production of methylated spirits used in the arts. They might safely conclude that upwards of sixty million bushels of grain were last year consumed in the manufacture of beer and spirits for purposes of beverage, being equal to two bushels for every man, woman, and child, in the kingdom. In other words, an amount amply sufficient for the annual sustenance of upwards of six millions of people. Intoxicating liquors were not food in any sense; that was the latest verdict of science, and corresponded with all the conclusions of common sense and unmistakeable experience. No one had a natural instinct or healthy craving for alcohol. It was not a sustenance, but a seductive poison. The liquor traffic and the drinking usages it promoted were therefore "barriers interposed between our wants and an abundant supply" of food. No wise Government, and no high-minded statesman, would deliberately choose to derive the executive resources of the nation from a system that directly tended to promote scarcity of food, and to multiply the means and facilities for vicious indulgences. The liquor traffic, as now existing, and as it had always existed, where suffered to exist at all, was, and ever had been, a fountain of social pollution and national impoverishment. It took the food of the people to convert it into that which is not bread, and which satisfied not, but which worked in a thousand ways to promote scarcity, sorrow, and desolation in the land. What, then, was the remedy for the evil which was so palpably prevalent and so deplorable? There was but one remedy,—simple, potent, effectual. Make it illegal and criminal to convert food into poison, and to tempt the ignorant and reckless to the purchase and use of intoxicants. There had been periods in the history of our nation when distillation had been prohibited, and when the happiest results had been realised. The tables of imports into Ireland (which, with other statistics, were quoted) showed, by comparison of the years of stoppage of the distilleries with the years when they were in full activity, that a year of scarcity, with prohibition, was better than a year of plenty without it. In addition to the decrease of disorder, crime, pauperism, and disease, and all their cost and consequences, it was seen that the revenue itself was greatly benefitted by the increased consumption of other articles. There must be some powerful and all-prevalent reason why strong liquors were treated in an exceptional manner. Why should every other manufacture in the kingdom be emancipated from the heavy and embarrassing hand of the Excise officer? How to bridge over the transition chasm was the real difficulty. In conclusion, the suggestion of the United Kingdom Alliance, that Parliament should pass a permissive measure, was adduced as the mode of suppressing the evil.

Thanks were passed to Mr. Thompson; and the section adjourned at five o'clock.

SECTION G.—MECHANICAL SCIENCE.

Mr. J. F. BATEMAN, president of the section, took the chair, at the Peter-street Schoolrooms, at eleven o'clock.

Mr. CHARLES VIGNOLES, F.R.S. read a paper "On iron construction, with remarks on the strength of iron columns and arches," by Mr. F. W. Shields. The author noticed the apparent inconsistency in the circumstance that British iron was conveyed to Australia, Russia, and other parts of the world, when the cost of the iron alone exceeded the cost of the stone and other materials which it was intended to replace. He accounted for this by the facts that iron possessed, size for size, more strength than any other material, and possessed a pre-eminent capacity for being manufactured into various shapes and sizes. He proceeded to give statistics of the strength of iron columns and arches.—Mr. Scott Russell thought the meaning of Mr. Shields's paper was this, that taking the very valuable experiments of Mr. Fairbairn and Mr. Hodgkinson, which would give say 2½ tons upon the square inch upon the breaking weight of the

column when you come to a certain degree of thinness you would have to reduce that proportion on account of the exceptional thinness of the iron, and thus, while one square inch of the iron might bear 2½ tons, in half an inch you must reduce the proportion to 1½ tons, and if you came as thin as ⅛ of an inch the column would only bear one inch to the ton. This was a valuable contribution to their statistical knowledge.

Mr. B. B. STONEY read a brief paper "On the deflection of iron girders."

Mr. EDWARD T. BELLHOUSE read a paper, illustrated with numerous diagrams and models, "On the applications of the hydraulic press," in which he traced the history of the hydraulic press from the first patent granted in the year 1785 to Mr. Joseph Brammah for his hydrostatic press down to the present day, and described its various uses and applications, entering into a minute description of various parts containing more or less of novelty either in application or design. He mentioned, in conclusion, that there were many portions of the presses which required the attention of scientific men. One of these points was this, many of the presses were sent abroad to places where facilities for transport were few, and there the weight of metal was a great disadvantage. He trusted Mr. Bessemer, or some other scientific man, would bestow attention on the subject.—The CHAIRMAN observed that Mr. Bessemer was present, and perhaps he could give them some information as to whether a lighter kind of metal was likely to come into use.—Mr. BESSEMER said he believed cast iron, without that quantity of carbon found in the metal usually known as cast iron, would be eventually used. Experiments were being made and castings had been effected, though a size large enough to be used in hydraulic presses had not yet been obtained.—Mr. OLDHAM mentioned that in oil mills the hydraulic presses were worked with oil instead of water, and this plan of course very considerably diminished the wear and tear of the machinery.—Mr. R. ROBERTS drew attention to the mode practised by the Italians in manufacturing lead pipes by hydraulic machinery. The lead was used cold instead of hot, and when one piece was nearly done, another piece was put into the tube, so that they could produce a pipe of any length.

Mr. JOHN ROBINSON read a paper "On the application of workshop tools to the construction of steam engines and other machinery." He enumerated and described the most important tools employed, and alluded to the enormous increase in the exportation and manufacture of machinery as a proof of the important revolution which these machine tools had brought about.

Mr. JOHNSON read a paper "On the best arrangement of stationary engines on the reciprocating principle." He said that, whilst immense improvements had been made in almost every other class of machinery, the stationary beam engine remained almost in the same state as when it first left the hands of the maker, and was one of the most imperfect pieces of mechanism of the present day. He compared the beam engine with the direct action engines, which he said were superior to the beam engine in these points,—they were independent of the foundation and engine-room walls for support. They were less liable to derangement and to breakage, and when a breakage did occur, it was less serious in its results than in the beam engine, and the condensing apparatus was easy of access.—Professor WILLIS, who had taken the chair in the temporary absence of the President, said the points brought forward in the paper just read were well worthy the attention of mechanical men.—Mr. SCOTT RUSSELL thought there were many who would agree with the author in his original proposition, that to get an economical, durable, and reliable engine it was not necessary to go back to the beam engine. In marine engines, the beam engines, which were long the favourites, had been given up almost universally. He believed the popularity of the beam engine was to some extent explained by the fact that originally stone work and masonry were cheaper than iron frames, but this was no longer the case. He believed the direct-acting engine would shortly entirely supersede the side lever engine.—Mr. HOPKINSON advocated the horizontal engine. Mr. ROBERTS said he agreed with Mr. Johnson as to the desirability of direct-acting engines, and he agreed generally with the horizontal engines.—Mr. CLAY reminded Mr. Scott Russell that one of the most successful shipbuilding firms, Messrs. Robert Napier and Co. still adhered to the beam engines, and in one of the Cunard steamers, the Scotia, now building in the Clyde, were introducing the ordinary beam engines.—Mr. WILLIAM SMITH remarked that these side-lever engines of Messrs. Napier, to which allusion had been made, were about the greatest coal-eaters, and were the greatest weight per horse power, of any engines built.

THE RESISTANCE OF SHIPS.

A paper by Professor MACQUORN RANKINE, "On the resistance of ships," was read. The Professor entered into a number of mathematical calculations, with a view of showing the amount of resistance which various forms of vessels received from water.—Mr. SCOTT RUSSELL said the gist of Professor Rankine's paper was this,—that in a certain shape of vessel the resistance of the water was simply confined to the adhesion of the water to the skin of the vessel, or what was termed "skin adhesion." The form of vessel which secured this important result was the "wave line." Now this was a more sanguine view of the wave principle than even he (Mr. Scott Russell), its oldest advocate, had ventured to take, though he might mention that a friend of his—Professor Hamilton, of Dublin—had arrived at the same conclusion some time ago. There were two forms of resistance—the first the skin resistance, and the second, and most important, the resistance of displacement. The ship had not only to remove the water sticking to its skin, but had also to remove the water out of its way. The probable amount of this resistance had been calculated by taking the measurement of the vessel amidships and calculating how much force was necessary to remove all this water to allow the ship to take its place. Professor Rankine said that this resistance had been reduced to nothing in the vessels of the wave form. The utmost he (Mr. Scott Russell) had ever ventured to say was that it was reduced to one twelfth. In the second part of his paper Professor Rankine took the question of the proportion of resistance of vessels not of the wave form, and he showed, by his experiments, that vessels not of the wave form had still to encounter a large proportion of the resistance due to having to lift the water out of the way of the ship. It was this point which the Committee of the Association urged upon the Admiralty to ascertain by experiment, and this paper of Professor Rankine was an additional reason why experiments should be made.

THE WHITWORTH PROJECTILE.

Mr. SCOTT RUSSELL said he was about to qualify a statement he made at the end of the discussion on Saturday, with reference to the elongated projectile of Mr. Whitworth. He did so at the request of Mr. Aston, who on that day read a paper on Mr. Whitworth's projectile. He did so at this point because the resistance of air to the progress of a projectile and the resistance of water to the progress of a ship were nearly identical, and therefore it was that Mr. Aston expected of him that he would admit some of the value of giving a fine form to a projectile. He would now give Mr. Aston and Mr. Whitworth the benefit of what was in their favour, and which he did not state. Although what he said then was perfectly true that for high velocities of ten, eleven, and twelve hundred feet per second, the form of the projectile was of no advantage; but for the lower velocities of six, seven, and eight hundred feet per second, it was. In the long ranges of Mr. Whitworth's guns the projectile did come down to a velocity of seven or even six hundred feet per second, and then there was a chance of the shape of the hinder-part of the projectile increasing the force with which the air found its way into the vacuum, and therefore the advantage of shape would be felt at this low velocity

There was another point on which he felt it necessary to do justice to the views of Mr. Aston. As was explained by Dr. Robinson, the projectile maintained its course nearly at the same angle at which it was fired from the gun. The direction of its motion being different from the direction of its axis, the resistance of the shot was increased with the angle. Therefore it was clear that the resistance it incurred would increase in proportion to the side it presented to the air, and the removal of a certain quantity of metal from the top and the bottom of the projectile would certainly diminish the resistance from the air.—A MEMBER, rising in the body of the room, remarked that at low elevations the increase of range was found to be 20 per cent, and at high elevations 50 per cent, in the tapered projectile; so that they looked for something more than Mr. Scott Russell had mentioned to explain this great increase.

The PRESIDENT said it was now nearly three o'clock, and, as the last paper on the list, "On the recent improvements in cotton gins," was a subject in which much local interest would be taken, he thought it better to defer that paper until the morrow, when it would have an early place in the proceedings.

The section then adjourned until Tuesday.

PROCEEDINGS OF THE SECTIONS.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

The section met at eleven o'clock; Professor AIRY, the president, in the chair.

The PRESIDENT, in opening the proceedings, referred to the large number of papers before the section. It was probable that they would not be able to get through them in the course of the day, and in that case they proposed to sit to-morrow (this day) at ten o'clock instead of eleven.

THE EXCHANGES OF HEAT.

Mr. BALFOUR STEWART submitted a report "On the theory of the exchanges of heat." He gave an historical account of what Prevost, Leslie, Kirchhoff, Tyndal, Fourier, himself, and others had done on the subject. The theory supposes that in a field of uniform temperature, each body is constantly radiating heat, and receiving back as much again, so that its temperature is neither increased nor diminished. The result arrived at, both theoretically and experimentally, was that in such a field the absorption of a particle was equal to its radiation and attraction for every description of heat or light. This result had been applied by Kirchhoff to determine the constituents of the solar atmosphere, and it was shown to depend ultimately on the very simple principle of action and re-action. In the course of his paper Mr. Stewart stated that to Fraunhoer must be attributed the discovery of definite lines in the solar spectrum.

The PRESIDENT observed that many of the points alluded to in the paper were not new, but admitted facts, nevertheless there were several parts of the communication which were exceedingly valuable.

Sir DAVID BREWSTER said that Mr. Stewart had made a mistake in ascribing the discovery of definite lines in the solar spectrum to Fraunhoer, instead of to our countryman, Dr. Wollaston. It was notorious that the discovery was made by Dr. Wollaston.

The PRESIDENT remarked that Sir David Brewster was right. It was undoubtedly a fact.

Mr. ROBERT MALLET made a communication "On earthquake wave experiments," which he illustrated by a number of diagrams. His experiments were made at the Holyhead government harbour works now in progress, at the instance of the Royal Society as well as the British Association. The experiments were made with the assistance of a galvanic battery; and the results at which he had arrived were that the extreme velocity of earthquake waves did not exceed 80 feet per second,—a fact which Humboldt had observed.

The communication was followed by a short discussion, in which the President and some other members of the section joined.

The PRESIDENT remarked that it was a most valuable communication indeed.

THE OPTICAL STUDY OF THE RETINA.

Sir DAVID BREWSTER read a paper "On the optical study of the retina." There were two structures in the retina that could be exhibited by optical means, the one by the successive impulses of light, and the other by the action of faint light entering the eye, or produced within it, either from the duration of a luminous impression, or from a local pressure upon the retina. The first of these structures was best seen by the light of a white cloud through the slits or apertures of a revolving disc, placed midway between its circumference and its centre of rotation, in order to protect the eye from light which did not pass through the slits. When the disc revolved rapidly, the field of view exhibited neither colour nor structure, but merely a diminution of light. When the velocity had reached a certain point the field of view became yellowish white, then yellow and bluish. Occasionally the yellow had the form of a rectangular cross, between the branches of which were dark spaces. With a diminished velocity the whole field became uniformly blue, and was now covered with hexagonal patterns. The other structure, which consisted of dark quadrangular lines, separated by treble or multiple parallel lines of bright light, had no relation to the hexagonal patterns. It suffered no change when impressed upon the foramen, and therefore represented a structure behind that in which the foramen existed. As there were no less than eight different layers in the retina it was of great importance to ascertain the functions which they individually performed in conveying visual impressions to the brain. It was only by optical means that this inquiry could be conducted. The anatomist had ably performed his part with the aid of the microscope, and, it was probable, from the improvement of this instrument chiefly, that they could not expect any further discoveries unless the morbid anatomy of the retina should connect certain imperfections of vision with the condition of certain layers of the membrane. When the retina was acted upon by galvanism, by pressure applied externally, or occasioned by congestion, or when it was in one of those abnormal states produced by fever, excitement, or fatigue, or other influences of a morbid nature, very remarkable colours had been seen and described by Ritter, and others. Ritter found that the positive pole of a galvanic battery applied to the eye-ball produced a sensation of blue and violet, that the negative pole gave a red colour,—that an increased galvanic power changed the blue and violet into green and yellow, and the red into blue. At a former meeting of the Association he had occasion to show that when the retina had not been excited by light, the part of it corresponding to the foramen was longer than the surrounding portions in receiving any impression from feeble lights, and for an instant appeared as a black spot: and that when the retina had been excited by light, the same part was more sensible to feeble light, and appeared luminous. He had also shown that when the eye was left in darkness by the sudden extinction of light, there were several points at the margin of the retina which retained the lights longer than the rest. There could be no doubt that those effects were produced by structural differences. They had consequently an optical principle which enabled them to explain the quadrangular structure he had described. The luminous lines represented a linear structure in one of the layers of the retina, which retained feeble impressions of light longer than the quadrangular portions which they enclosed, and the same was true of the parts of the retina represented by the luminous points of its margin. This property was probably owing to a difference of density, or thickness, or some other conditions, in the different parts of the membrane, or layer, which anatomists had shown to exist between the central and other parts of the retina, considered as one membrane. It was not improbable, when they looked at the complete structure of the retina, and even of its undivided layer, that the structures of each of them might be exhibited optically. He had observed two structures different from those he had described, under degrees

of illumination, when the dark spot of the foramen was wholly invisible. In one of these the figures were circular lines, less than a semicircle, and in the other they were perfectly quadrangular patches of shade and other irregular form; but in both of the figures the circular lines and patches were regularly arranged like the patterns of a carpet, and no lines or patches appeared on the spot corresponding to the foramen. When any of these forms were seen while the observer was not in perfect health, the imperfection of the figures might arise from the same cause which produced hemiopsy, or other local irregularities of vision, which depended on a peculiar state of the retina.

A short discussion having taken place on the paper,

The PRESIDENT said the scientific public were much indebted to Sir David Brewster, who had first taken up this important question, and thrown great light upon it. He was glad that Sir David was following it up, for he felt assured that it would be of great service to the Association. He was sure that he might offer to him the thanks of the section.—(Cheers.)

Mr. J. S. STUART GLENNIE next read a paper "On the application of the principle of the conservation of force to the mechanical explanation of the correlation of forces;" and also another paper "On the resistance of the ether to the comets and planets, and on the rotation of the latter."

THE MOON'S SURFACE.

Professor PHILLIPS communicated a paper entitled, "Notes of sketches of parts of the surface of the moon." He stated that the paper had been prepared in accordance with the direction of the General Committee at Oxford, for an examination of the surface of the moon, with the view of discovering the character of her surface as influenced by previous physical events. He entered into an elaborate account of the observations which he had made, which he illustrated by a number of diagrams exhibited.

An interesting discussion followed upon the reading of the paper.

The PRESIDENT would ask Mr. De la Rue if the most desirable way of drawing the moon's surface was not photographically?

Mr. DE LA RUE agreed with the President that the best way was to commence drawing the surface of the moon photographically, because lunar photography had reached such a degree of perfection that the main outlines were given with great precision. On the other hand, a photograph might not give the true colouration on the moon's surface. There was a marked distinction between the light and shade of the lunar surfaces as photographed, and as seen with the telescope.

The Rev. T. RANKIN communicated a paper "On meteorological observations;" after which Mr. W. S. JEVONS read a paper "On the deficiency of rain in an elevated rain gauge, as caused by wind."

COAL MINES AND THE TEMPERATURE OF THE EARTH'S CRUST.

Mr. FAIRBAIRN, the president of the Association, submitted the following, "Remarks on the temperature of the earth's crust, as exhibited by thermometer returns, obtained during the sinking of the deep mine at Dukinfield." He said:—It is now more than ten years since a series of experiments were commenced to determine the temperature at which certain substances become fluid under pressure. These experiments had reference to the density, point of fusion, and conducting power of the materials of which the earth's crust is composed, and were prosecuted with a view to the solution of some questions regarding the probable thickness of the earth's crust. Contemporaneously with these, we were fortunate in being able to ascertain by direct experiments, under very favourable circumstances, the increase of temperature in the earth's crust itself. These observations were obtained by means of thermometers placed in bore-holes at various depths, during the sinking of one of the deepest mines in England, namely, the coal mine belonging to F. D. Astley, Esq, at Dukinfield. The bore-holes were driven to such a depth as to be unaffected by the temperature of the shaft, and the thermometers were left in them for periods varying from half an hour to two hours. It is very difficult to arrive at accurate data on the subject of the increase of temperature in the earth's crust. The experiments hitherto made give, unfortunately, somewhat conflicting results, and even in the same mine the rate of increase of temperature is by no means uniform. This is shown very clearly in the results obtained by Mr. Astley. It is scarcely probable, however, that the temperature in the mine shaft influenced the results, and we must therefore seek the cause of this irregularity in the varying conducting power of the different strata, arising from different density, and different degrees of moisture of the strata. As to the rate of increase, they appear to confirm previous experiments, in which it has been shown that the temperature increases directly as the depth. The rate is at first rather less than this, afterwards somewhat greater, and at last again less, but on the whole the straight line on which the temperature increases as the depths nearly expresses the mean of the experiments. The amount of increase indicated in these experiments is from 50° to 57½°, as the depth increases from 5½ yards to 231 yards, or an increase of 1 deg. in 99 feet. But if we take the results which are more reliable, namely, those between the depths of 231 and 685 yards we have an increase of temperature from 57½ deg. to 70½ deg. or 17½ deg. Fahrenheit. That is a mean increase of 1 deg. in 76·8 feet. This rate of increase is not widely different from that observed by other authorities. Walferden and Arago found an increase of 1 deg. in 59 feet in the artesian well at Grenelle. At the salt works at Rehme, where an artesian well penetrates to a depth of 760 yards, or rather more than the Dunkinfield mine, the increase is 1 deg. in 54·7 feet. MM. de la Rive and Marcet found an increase of 1 deg. in 57 feet at Geneva. Other experiments have given an increase of 1 deg. in 71 feet. In one respect the observations in the Dukinfield mine are peculiarly interesting. As they give the temperature in various descriptions of rock, they appear to prove what has hitherto been partially suspected—namely, that the conducting powers of the rocks exercise a considerable influence on the temperature of the strata. If we add to this the influence of the percolation of water, we shall probably have a sufficient explanation of the irregularities observed in the experiments. From the above observations we have evidence of the existence in the earth of central heat, the temperature, so far as can be ascertained, increasing in the simple ratio of the depth. I do not, however, presume to offer an opinion as to whether this increase continues to infinitely greater depths than we have yet penetrated, as observations upon this point are still imperfect. But, assuming as an hypothesis, the law which prevails to a depth of 700 yards, continues to operate at still greater depths, we arrive at the conclusion that at a depth of less than two and a half miles the temperature of boiling water would be reached, and at a depth of 40 miles a temperature of 3,000° Fahrenheit, which we may assume to be sufficient to melt the most refractory rocks of which the earth's crust is composed. If, therefore, no other circumstance modified the conditions of liquefaction, all within a thin crust of this thickness would be in a fluid state. This, however, is not the case. At these depths the fusing point is modified by the pressure and conductivity of the rocks. We know that in volcanic districts, where the great subterranean laboratory of nature is partially opened for our inspection, the molten mass, relieved from pressure, pours forth from volcanic craters currents of lava which form a peculiar class of rocks. Besides this, it has been ascertained by Mr. Hopkins's experiments on soft substances, such as spermaceti, wax, and sulphur, that the temperature of fusion increases about 1·3 Fahrenheit for every 500lb pressure per square inch, that is, in other words, that the temperature of fusion under pressure is increased in that ratio. If we

assume this to be the law for the materials of the earth's crust, and correct our previous calculations in accordance with it, we shall find that we shall have to go to a depth of 65 miles, instead of merely 40, before the point of fusion of the rocks is reached. It must, however, be observed that Mr. Hopkins's later experiments with tin and barytes, do not show such an increase of the point of fusion in consequence of pressure, and he is led to the belief that it is only in the more compressible substances that the law holds true. Independently of this, however, Mr. Hopkins points out to me that in the above calculation it is assumed that the conductivity of the rocks is the same at great depths as at the surface. In opposition to this he has shown experimentally that the conducting power for heat is at least twice as great for the dense igneous rocks as for the more superficial sedimentary formations of clay, sand, chalk, &c. And these close-grained igneous rocks are those which we believe must most resemble the rocks at great depths below the surface. Now, Mr. Hopkins shows that if the conductive power were doubled, the increase of depth, corresponding to a given increase of temperature, would be doubled, and we should probably have to descend 80 or 100 miles to reach a temperature of 3,000 deg. besides the further increase which investigation may show to be due to the influence of pressure on the temperature of fusion. Mr. Hopkins therefore concludes that the extreme thinness of the crust assumed by some geologists to account for volcanic phenomena is untenable. Calculations on entirely independent data led him to conclude that the thickness did not fall short of 800, instead of 30 or 40 miles. If it be so much, he is further led to believe that the superficial temperature of the crust is due to some other cause than an internal fluid nucleus. It remains a problem. therefore, which my friend, Mr. Hopkins, is endeavouring to solve, as to what is the actual condition of the earth at great depths, and the relation of terrestrial heat to volcanic phenomena.

Mr. HOPKINS said the communication which had been made by the President of the Association was worthy of more confidence than any which had hitherto been given to the public. No former treatises on this point had so largely taken into account the various circumstances in connection with mines, and the causes incident to them, which affected the temperature of the earth's crust. The condition of the rocks and walls, as well as the water in mines, must necessarily have a varying effect upon the temperature, and these facts had not received sufficient attention at the hands of those who had made experiments, but the President had now gone largely into it One great advantage likely to result from the experiments explained in the President's paper was that the experiments had been made in a virgin mine, before it had been worked, and the temperature ascertained before being altered by working. Now, as regarded the mine in question, the strata was very much inclined, and there was a good deal of water in it. That being the case, great caution was required in working it, because a wet mine gave a higher temperature than a dry mine. Hitherto there had been very great difficulty in making observations and experiments in mines He had had some discussions with Professor Phillips, on the subject, and he hoped that before long they would arrive at some process by which they would be enabled to make more satisfactory and conclusive experiments of the continually varying temperature in these mines, and its effects upon the encrustation of the earth. He referred, at some length, to his own experiments in mines, remarking that the temperature sensibly affected the earth's crust. He did not mean to say, as had been asserted by some, that the earth's crust was 800 miles, but he felt satisfied, from his own observations, that it must be more than 100 or 200 miles.

Professor HENNESSEY spoke at some length on the subject, disputing the views advanced by Mr. Hopkins as to the extent of the earth's crust. He was proceeding with a general argument, when—

The PRESIDENT interposed, and said Professor Hennessey was going into a detailed mathematical question, which was not exactly before the section. He admitted that it was a most important question, but he thought it was inconvenient now to go into the details of the mathematical part of the subject, for Mr. Hopkins would have to reply, and they were very much pressed for time.

Professor HENNESSEY said that after the President's remarks he would not go further into the subject.

The PRESIDENT remarked that he felt it was a very important subject indeed, and he was unwilling to prevent the discussion proceeding, but Professor Hennessey would no doubt see the position in which the section was placed as regarded time.

Mr. HOPKINS said that when the opportunity served, he should be quite prepared to combat Professor Hennessey's theory.

The PRESIDENT of the Association (Mr. Fairbairn), said he might observe that the whole of the upper surface of this mine, to 1,200 feet, discharged water, but below it was quite dry.

After some further discussion, on the motion of the President, a vote of thanks to Mr. Fairbairn, for his valuable paper, was carried by acclamation.

Mr. ISAAC ASHE next read a paper "On the causes of the phenomena of cyclones," followed by Dr. MORGAN, with a paper "On a new registering anemometer." Mr. P. J. LIVESEY next read a paper, 'On the new barometer invented by Mr. R. Howson."

ELECTRICAL STANDARDS OF MEASUREMENT.

Mr. LATIMER CLARKE and Sir CHARLES BRIGHT submitted a communication "On standards of measurement of electrical quantities and resistances." Mr. Clarke said the reason why the subject had been brought before the section was this:—At the present time there was no agreement at all as to electrical standards of measurement; and they wished the British Association to give their authority and sanction to some well-defined and settled standard, which should in future be a fixed guide. It was with that view that the paper was brought before the section. He would not read it, as it would not be generally interesting. He would simply lay it on the table, in the hope that the subject might receive the attention of the Council of the Association.

The PRESIDENT said he had no doubt the subject would have the careful consideration of the Council.

The section, at four o'clock, adjourned until ten o'clock on Wednesday, there being several papers yet to dispose of.

SECTION B.—CHEMICAL SCIENCE.

Mr. W. R. GROVE, M.A. F.R.S. took the chair at the meeting of this section, at Owens College, about ten minutes after eleven o'clock.

Mr. J. J. GRIFFIN, F.C.S. made some remarks "On the construction of gas burners for chemical use." By means of apparatus arranged on the table before him, he gave specimens of the flames produced by the gas-burners. They were, he said, of so powerful a nature, as to be capable of boiling large quantities of liquid, and of reducing metal in a very short space of time. The most remarkable of the flames produced by Mr. Griffin from the gas-burners, was one which answered the purpose of the blow pipe. The apparatus made use of for this purpose, consisted of two chambers. The flame at first produced appeared to be about three feet long, and it presented the colour of an ordinary flame of gas, but when Mr. Griffin placed upon this flame a part of the apparatus, it was immediately reduced to a flame of about three inches in length, and it assumed the usual appearance which the inner, or reducing flame of the blow pipe presents. He said that this flame passed, in fifteen jets, from apertures round the burners, was of great reducing power.

Dr. CRACE-CALVERT said that he thought chemists were obliged to Mr. Griffin, for he had conferred upon them a great benefit by this ingenious application of the gas

flame.—Dr. ALEXANDER said that he found this flame exceedingly convenient in the analysis of silicious minerals.

PERCHLORIC ACID AND ITS HYDRATES.

Professor H. E. ROSCOE, B.A. read a paper which excited great interest, of which the following is a summary:—It was well, when the progress of chemistry was exerting itself in the increase of an immense series of organic compounds, that we should be reminded that we had still a great deal to learn concerning the most simple compounds, and that of many of the substances which occur most commonly, we know but little. All the knowledge we possess of the quantitive relations of perchloric acid is the determination of the composition of the potassium salt, first analysed by Stadion, 1816, and afterwards by many other chemists. The perchloric anhydrous acid has not been isolated, and no analysis of the aqueous acid has ever been made. We can only account for the neglect with which chemists have treated the highest and yet the most stable of the oxides of chlorine, by the fact that the preparation of the acid in larger quantities has been attended with great difficulties. The best method for preparing aqueous perchloric acid is to decompose chlorate of potassium with hydrofluosilicic acid, to boil the chloric acid thus obtained down, which splits up into lower oxides of chlorine, which escape in the gaseous state, impure perchloric acid being left behind, which is purified by distillation. The acid thus obtained is in appearance not to be distinguished from oil of vitriol, being a colourless, heavy, thick, oily, corrosive liquid, giving off by heating dense white fumes. By heating the aqueous perchloric acid with four times its volume of concentrated sulphuric acid, the latter takes water from the first, dense white fumes are evolved, a yellow mobile liquid distils over, afterwards thick oily drops appear, which, when coming in contact with the yellow liquid form white crystals, previously obtained by Serullas, but in such small quantities that he was unable to analyse that substance, which, prepared in this way, contains always sulphuric acid, and is therefore not fit for analysis, and requires re-distillation. Heated, however, to 110 deg. C. the crystals decompose, and split up again in the yellow liquid, which distils over at a low temperature, and the thick oily liquid remains in the retort. The yellow liquid thus obtained is pure perchloric acid, a body not known before, and can be obtained also by distilling one atom of perchlorate of potassium with four atoms of sulphuric acid. In the pure state it is perfectly colourless, but commonly slightly yellow, owing to the presence of lower oxides of chlorine. Perchloric acid is one of the most powerful oxidising agents known; a single drop brought in contact with charcoal, paper, wood, alcohol, &c. immediately causes explosive combustion, falling not short in violence of that of chloride of nitrogen, and when brought on the skin fearful wounds are produced, which do not heal for months. Like nitric acid it cannot be distilled without decomposition, but it darkens, and heated stronger, decomposes with explosion. It cannot be kept for any length of time; even sealed up in glass bulbs, which are placed in the dark, it decomposes suddenly after some time, smashing the vessel containing it. It mixes with water with a hissing noise and evolution of heat, nitring and forming the same crystals which were mentioned before, and were used for preparing the pure acid. Those crystals are the monohydrated perchloric acid. They melt at 50 deg. C; and, heated to 110 deg. C, split up in pure perchloric acid, which distils over, and an oily liquid boiling at 200 deg. which is also obtained by boiling aqueous perchloric acid till dense white fumes are given off. That oily acid has a constant composition containing 72·3 per cent. pure perchloric acid, and 27·7 per cent H^2O.—. This per centage corresponds, however, to no definite hydrate of simple atomic composition, but follows the same general relations respecting composition and boiling point, which, as I have shown previously, hold good for so many aqueous acids,—namely, that the phenomena of constant boiling point and constant composition depend chiefly upon physical and not on chemical attractions.

Dr. ALEXANDER considered that Dr. Roscoe's paper was a very remarkable one, for he had taken up a substance which had been known for a great many years, and made the subject of investigation by chemists of eminence. That substance had been most successfully investigated by Dr. Roscoe, who had succeeded in bringing out from it new and unexpected features of interest.

A paper, by W. H. Hurst, "On the sulphur compound formed by the action of sulphuretted hydrogen on formiate of lead at a high temperature," was read; and Dr. RUSSELL read a paper prepared by himself and Dr. Matthieson, "On the vesicular structure in copper."

Dr. DAUBENEY made a few remarks "On the evolution of ammonia from volcanoes." He considered this subject to be a most extraordinary phenomenon. It was well known that ammonia was evolved from volcanoes.

THE HISTORY OF THE ALKALI MANUFACTURES.

Mr. W. GOSSAGE read a paper on this subject. He said it was correct, he believed, that the manufacture of soda in Great Britain, by the special decomposition of common salt, had its commencement in Lancashire; at any rate its largest development had taken place in this county. Previously to the establishment of the French republic, in 1793, soda was obtained almost entirely from the ashes of marine plants growing at Alicante, in Spain, Sicily, Teneriffe, and on the coast of Great Britain. Large quantities of potash were also imported from Russia and America, but now soda was exported to those countries which formerly sent us potash. The importation into France of alkali being stopped by the French revolution, a committee was appointed by the French convention to discover means of supplying the article from France alone. The process suggested by Le Blanc was approved of, but it was erroneous to suppose that his process was not invented before the committee was appointed. Having given an account of Le Blanc's invention, Mr. Gossage said that it was very complete, and was the same as now used in both England and France. This invention had done more to promote civilisation than any other chemical manufacture. The poor inventor, however, met with the too common reward of talent, and after great privations died in an asylum for paupers. Alkali works were soon erected in France; but the process was not introduced into England for some years afterwards. In 1787 Messrs. Gordon, Barrow, and Co. of Aberdeen, applied chlorine, then recently discovered, to the process of bleaching. A large establishment was, in the following year, established at Bolton. At first chlorine was used in the state of solution in water, but the inconvenience of using it in that manner was overcome by the addition of potash to the water. The next step was to substitute lime for potash, producing solution of chloride of lime. This was the invention of Mr. Charles Tennant, of St. Rollox, who afterwards manufactured chloride of lime in the state of powder. This manufacture was carried out to a great extent. A great obstruction to the manufacture, however, was the high excise duty on salt, which operated most injuriously. When Mr. Tennant's patent for manufacturing bleaching powder expired, other parties began the same manufacture. Attention was directed to the utilisation of the mixed sulphate of soda and sulphate of manganese resulting from this manufacture, and carbonate of soda, in crystals, was gradually introduced into the market. During the same period, Mr. Losh was making crystals of soda, and might be considered the father of the soda trade in this country. Mr. Losh finished his education on the continent, where he learnt Le Blanc's processes. After his return, he obtained permission of government to work a spring of weak brine discovered at Walker, on the Tyne, for the manufacture of soda. He there manufactured soda crystals; but notwithstanding these essays, 1823 might be considered the natal year of the soda trade as a special manufacture in Great Britain. In that year common salt being relieved from fiscal impost, Mr. James Muspratt commenced the manufacture of sulphate of soda at Liverpool, to be used for the manufacture of carbonate of soda. Mr. Muspratt

adopted Le Blanc's processes in their entirety. He had to contend with many difficulties, but he overcame them all, and reaped a satisfactory reward. Other manufacturers also commenced to make sulphate of soda, by the special decomposition of common salt, for the purpose of making soda; and it has since been found advantageous to adopt this method of working to the production of bleaching powder, by using the hydrochloric acid so obtained to generate chlorine by its action on manganese. In the early days of the soda trade no attempt was made to condense and liberate hydrochloric acid gas. The old apparatus of cylinders and Wolfe's bottles was totally inadequate for the condensing. Many plans were suggested, amongst others he (Mr. Gossage) obtained a patent in 1836. Having demonstrated the practicability of effecting a complete condensation of hydrochloric acid, by the erection and working of a set of apparatus at the soda works with which he was then connected, he introduced the plan to the trade, and it had been subsequently adopted by every manufacturer. The principle of the invention consisted in causing the acid gas to percolate through a deep bed of coke, in small lumps, contained in a high tower, at the same time that a supply of water flowed very slowly over the surfaces of the pieces of coke. By this means, an almost unlimited extent of moistened surfaces might be presented to the gas for effecting its absorbtion, and as the same fluid descended through the tower, it met with more gas and gradually became charged to saturation, whilst, at the upper portion of the tower, any gas which might otherwise escape was exposed to the absorbing power of unacidulated water. In 1838, a French house, Messrs. Fai and Co. of Marseilles, obtained a monopoly from the King of Sicily for the export of sulphur. This caused an advance in price to £14 per ton, from the previous rate of £5 per ton. It was soon found that in our Cornish mines and in those of Wicklow, in Ireland, we possessed an inexhaustible supply of sulphur in the form of pyrites; our practical chemists soon availed themselves of this source, for the manufacture of sulphuric acid. In working with pyrites it was found that this mineral contained sulphide of copper, as well as sulphide of iron, and, at an early period, he commenced to extract the copper from the burned residuum by smelting. At the present time, the products obtained by the soda manufacturers were soda ash, worth £9 per ton; soda crystals, about £4. 10s. per ton; bleaching powder, £9 per ton; bi-carbonate of soda, £10 per ton; whilst the cost of raw materials, now used in Lancashire, are sulphur, £8 per ton, for which was substituted pyrites at a cost equivalent to £5 per ton; sulphur salt, 8s.; zincstone, 6s.8d.; fuel, 6s. per ton. Thus with a reduction in the cost of raw materials not more than equal to 10 per cent, the public was supplied with the products of the soda manufacturer at a reduction of at least 60 per cent. As nearly as he could obtain information, there were 50 establishments in Great Britain in which soda was manufactured by Le Blanc's process, producing about 3,000 tons of soda ash, 2,000 tons of soda crystals, 250 tons of bicarbonate of soda, and 400 tons of bleaching powder per week. The total amount of these products might be estimated as exceeding two millions sterling, which was so much entirely added to the annual income of the country, excepting about one hundred thousand pounds paid for materials obtained from other countries. He must not omit to notice the prospect of a new market for British made soda which had been opened by the successful labours of Mr. Cobden, in negotiating the commercial treaty with the French government. Many attempts had been made to supersede Le Blanc's process, by some more direct means of operating on salt; so as to eliminate its soda at once. Up to the present time, the result of all those attempts had been the wasteful expenditure of large sums of money. Two fifths of the total cost for raw materials was incurred for pyrites, from which to procure a supply of sulphur; and it was a well-known fact that more than nine tenths of this sulphur was retained in the material called "alkali waste," which was thrown away by the manufacturer. Thus was presented a problem which, if it could be solved, would effect a large reduction in the cost of soda. Many chemists, both scientific and practical, had given a great amount of attention to that subject. He had been so unfortunate as to be amongst the number, as he had devoted a great proportion of his time, during a quarter of a century, and a large amount of both money and labour to this hitherto delusive subject. He commenced by demonstrating in 1838, that one equivalent of sulphide of calcium, produced mono-carbonate of lime and sulphide of hydrogen. This decomposition was contrary to the received views of scientific chemists of that day, as it was held that an excess of carbonic acid was needful to effect the perfect decomposition of sulphides. He was convinced that whenever the utilisation of the sulphur in alkali waste might be effected, it would be by means of this action of carbonic acid. He demonstrated also, at the same time, that one equivalent of carbonic acid would decompose one equivalent of sulphide of sodium, producing mono-carbonate of soda and sulphide of hydrogen. His present impression was, that Le Blanc's process would be modified by the omission of lime, when decomposing sulphate of soda, thus producing sulphide of sodium; and, that, the carbonic acid, evolved by this decomposition, would be applied to decompose the sulphide of sodium producing carbonate of soda and eliminating sulphide of hydrogen, which would be absorbed by peroxide of iron, a product obtained in the manufacture of sulphuric acid from pyrites. He had proved the practicability of all those decompositions and actions; but the ideas had still to be worked out into a practical operation.

Dr. Angus Smith made some remarks on the great amount of information contained on this subject in Mr. Gossage's paper, and concluded by suggesting that the paper just read should be printed in full.

Dr. Gladstone, who had occupied the chair whilst this paper was read, stated that it was strictly speaking a matter for the consideration of the Association.

Dr. Williamson read a paper "On an apparatus for the rapid separation and measurement of gases," which he had prepared in conjunction with Doctor Russell.

Professor Tennant read a short paper "On a specimen of meteoric iron from Mexico." He said it was a portion of a large mass sent from Mexico.

Dr. J. H. Lloyd read a paper "On purifying towns from sewage by means of dry cloacæ."

Mr. William Mariott read a paper "On the separation of ammonia from coal gas."—During this day's meeting a communication from Sir James Murray was read, which was not in the programme; the President stated it had only been received that morning. Professor W. A. Miller, M.D. F.R.A.S. who had occupied the chair at all the former meetings of this section, was not present, during this day's proceedings.—The section adjourned about four o'clock.

Section C.—GEOLOGY.

Sir R. I. Murchison took the chair, in the lecture theatre of the Royal Institution. In the course of the day, Professor Jukes took the chair, in the absence of the president through other business engagements.

The first paper was by Mr. Salter, on "coal fossils." The point to which he chiefly directed attention was a peculiarity in the stems of some Sigillariæ—which are swelled at short intervals and give off roots from these modes or varices, between the leaf rows. These perfect preservation of the markings on the surface of the stem below and above these nodes, indicate that the roots were emitted in water, not in earth, and hence that sigillaria was a water plant. That it was sea water and not fresh water in which they grew must be held to be proved by the associated animal remains, and Mr. Salter proceeded to show that there were no good grounds for believing that any of the coal shells—not even the so-called "Unios" were of freshwater character. Of the three prevalent genera of coal shells, two had an epidermis, wrinkled strongly in the manner of the myadæ;—and indicating a like habit of burrowing in the mud; and

the third resembles modiola and aricula. Taken in conjunction with the presence of great numbers of marine annelids, and the tracks of large worms, the balance of evidence appears largely in favour of the entirely marine origin of coal.—A discussion ensued, in which Mr. Dickenson took part, and Professor H. Rogers, who had maintained, so far back as 1840, the marine growth of coal, urged strongly the enormous lateral diffusion of the coal forests as a confirmation of these views. He instanced the universal prevalence of salt and soda in the coal deposits as additional evidence.

Dr. HECTOR read a paper on the latter changes in the physical geology of British North America. His object was to show as a result of observations made in connection with Palmer's expedition, that the northern slope of the Continent had been submerged, to raise the great erratic drift, to the depth of 3,000 feet; and that during its gradual elevation the region has derived its present configuration of surface by denudation, first, as affected by sea coast lines on which were stranded ice floes, bearing erratics; and latterly, by the coast lines of ancient lakes, which confined the portion of them that at present exist, but were then of much greater extent. The superficial deposits on the north-east slope are thus principally composed of irregularly stratified drift deposits, with erratic blocks. On the west slope, on the other hand, the valleys were filled, and the level country is covered by accumulation of water-worn shingle that has in most cases been moulded into terraces. On the coast at Vancouver's Island, there, however, occurs a true deposit of drift with boulders. Dr. Hector then described several varieties in the method of gold mining, as practised in California—distinguished by differences in the nature of the deposit in which the metal occurs. He exhibited a sketch of one hydraulic method of mining, which consists of delivering a powerful stream of water against the conglomerate cliffs, from nozzles like those of a fire-engine. The supply of water for this purpose is in the hands of separate companies from those who conduct the mining, as the water is often brought from enormous distances through tunnels and by aqueducts. The whole water, with the material washed out of the cliff, is directed through long troughs like mill-leads, that run for miles. The stones are thrown out by men to save the wear on the bottom of the trough; and the gold is entrapped by amalgamation with mercury.

Dr. HECTOR also read a paper to show that the coal deposits of the Saskatchewan prairies and of Vancouver Island, which are of considerable value as fuel, belong to the age of the chalk.

Mr. D. M. HOME read a "Notice of elongated ridges of drifts, common in the south of Scotland, called the Kains."

GOLD IN NORTH WALES.

Mr. T. READWIN read a paper on this subject. He confined his observations to an area of about 20 square miles, situate north of the turnpike road from Dolgelly to Barmouth. Its metalliferous products are chiefly argentiferous galena, copper pyrites, blende, manganese, and mundic, associated frequently with native gold. The position of the quartzose vein in the Clogan Mine, distinguished as "the gold lode," which traverses altered palæzoic slates, near the junction of an eruptive bar of porphyritic greenstone, singularly confirms a remark in Sir R. I. Murchison's "Siluria;" and the same law appears to obtain with respect to all the gold-bearing quartzose veins of the Dolgelly district. There are, in that district, about twenty localities in which gold has been discovered, visible in quartz, or associated more or less with galena, blende, copper pyrites, telluric-bismuth, carbonate of lime, schist, baryta, iron pyrites, &c. By far the richest discoveries are at the Dol-y-frwynog, Prince of Wales, Cambrian, and Clogan Mines. Mr. Arthur Deane, at the meeting of the British Association in 1844, stated that auriferous veins had existed throughout the Snowdonian range; but experiments made to obtain it then, and ten years later, proved failures. The most interesting and most profitable of all the gold localities at present, is the mine in the Clogan Mountains, the St. David's lode being its most remarkable feature. The lode runs nearly east and west, and is almost perpendicular. It is three feet wide, and is composed of quartz, impregnated with sulphides of copper, lead, iron, and occasionally telluric-bismuth, with much native gold, generally in minute particles, but frequently in rich strings or bunches. This lode is at the junction of the Cambrian sandstones and the lingular flags of the lower Silurian rocks. Many years ago it was worked, and the produce, which was called "poor copper ore," was sold to Flintshire smelters, who asked for more at an advance of 5s. per ton. In 1854, the grass-grown refuse of this "poor copper ore" was examined, and in one instance 100lb weight yielded 14½oz. of gold. Difficulties connected with amalgamating machines, and the proceedings of two Chancery suits, prevented the value of this lode being proved until very recently. Thirteen experiments were made by the author, about twelve months ago, on a hundredweight of the auriferous quartz from this lode; the total result being 25 oz. 16 dwts. 7 grs. of amalgam, and 8 oz. 5 dwts. 19 grs. of fine gold. The active working results at the mine during the present year have been, 1,314 oz. of fine gold, from 207 tons 8 cwt. of quartz from the bulk of the lode. Adding to this 56 oz. the result of experiments upon five tons in 1860, there was a total of 1,370 oz. of gold from 212 tons of auriferous mineral, or at the rate of 6½ oz. to the ton. This, the author believes, is the first public record of a hundredweight of gold, of the value of £5,300 having been obtained from the crown lands of this country. The royalty is one-twelfth; the cost of extraction has been very inconsiderable; and there is a probability of a yield of gold at the present rate, for some time to come. For seven years the author has worked at a settlement of this vexed question; many at first doubted, and many more derided, the statement that gold exists, and can be profitably extracted, in the Dolgelly district; but results have proved that he was right. In conclusion, the author gave a list of the gold localities in the district; and a statement as to the association in which the metal is found at each.

THE BURNLEY COALFIELD.

Mr. J. T. WILKINSON read a paper, by himself and Mr. J. Whitaker, "On the Burnley coalfield and its fossil contents." Although of limited area, the Burnley coalfield is uncommonly rich, not only in fossil fuel but also in organic remains. It comprises within itself a complete series of the middle and lower coal measures. It is surrounded by ranges of hills; the principal of them being Pendle on the north, Boulsworth on the east, Gorple towards the south, and Hambleton on the west, several of them being nearly 2,000 feet above the sea level. Geographically, the field occupies the lowest portion of the valley; but, geologically, it is the highest, when considered with reference to the stratification of the district. The most productive part of the field underlies the town of Burnley, where it assumes the form of a long trough, bounded on the east and west by two faults, running nearly parallel. The greatest depth to which the strata has been pierced occurs on the Fuledge estate, near the centre of the basin, where a depth of nearly 300 yards has been obtained. There have been found the following seams:—The Dog Hole Mine, or top bed, 6ft. thick; Kershaw Mine, 3ft.; Burnley Old Five-feet Mine (the main coal of the field), 5ft.; Higher Yard Bed, 3ft.; Lower Yard Bed, 3ft.: Low Bottom Mine, 4ft.; Cannel Bed, 2½ft.; Thin Coal Mine, 2½ft.; Great Mine, or King Bed, 4ft. These are locally called "The top beds;" and they include about 40ft. of coal, embedded in strata about 600ft. deep. For a depth of 240ft. below these no coal occurs. Then come the Arley series, or Habergham Mines, consisting of the following working seams:—China, about 2ft. thick; Dandy Bed, 3ft.; Arley, or Habergham Mines, 4ft.: giving a total of 9ft. of coal to about 445ft. of intermediate strata. Strata not containing coal here again form another awkward division of the measures. The Ganister Mines follow next, comprising the Foot Mine, with

a hard gannister bed; the Spa Clough Top Bed, 2½ft.; Spa Clough Bottom Bed, 4ft.: or a total of 8ft. of coal, with 684ft. of intervening strata. From these measures to the Rough Rock, the highest part of the millstone-grit formation, the distance is something more than 300ft. Omitting many seams less than 1ft. thick, there is from the highest mine in the Burnley measures, to the highest member of the millstone-grit formation, a total of 51ft. of coal, for a depth of 2,025ft. of strata. None of the thin seams in the millstone grit have been worked in the Burnley district. The authors describe in detail the various seams mentioned, and the fossil remains found in each. In conclusion, they state that seven large specimens of sigillaria were found in the limited space occupied by a small cotton mill recently erected in Church street, Burnley; and others have been found in Mill Lane during the construction of a common sewer. The whole of these were in an upright position, and several had stigmaria roots adhering, giving the best possible evidence that they had grown and flourished on the spot. The whole of the overlying rock may be described as an immense fossil forest, occupying the central part of the Burnley coal-field; and that town itself is situated on what was one of its richest lagune jungles, replete with the Flora of a former geological neighbourhood.

The PRESIDENT said that the paper was of infinite value to all geologists in endeavouring to form general conclusions.—Mr. E. W. BINNEY said that Mr. Whitaker, Mr. Wylde, of Fuledge, and the gardener of Sir J. Kay-Shuttleworth, had examined the Burnley district with great care and skill. They had discovered there an amount of coal with which we were not before acquainted; for nothing above the Arley coal was known of until these indefatigable men set to work. For years it had been customary to say that the Burnley field was about to be exhausted; but it was now shown that it was likely to yield for a long time—certainly for thousands of years; for he feared that none of our coal fields was likely to last nearly as long as people had been in the habit of stating in books.—Mr. JOSEPH DICKINSON (government inspector of mines), said that until recently the Burnley field might be said to have been a closed one, so far as public knowledge was concerned, not because information was not possessed by the workers of mines, but from their inclination to keep to themselves what they knew. It was only during the last two or three years, since Sir J. P. Kay-Shuttleworth had taken an interest in the Manchester Geological Society, and through the exertions of those mentioned by Mr. Binney, that the public had really learned anything about the field. From Church on the west, to the Todmorden Valley on the east, this field was, as high as the gannister coal, connected with the main field of Lancashire. Above that level, it was disconnected by two great faults. The Arley coal was entirely gone from under Clayton Hall Estate; at Holtham and at Hepton, it was also gone; except perhaps a few pillars left in each place. At Habergham Eaves, there was a considerable quantity left, not only of the Arley Mine, but of the upper beds. To the north came the Burnley field, passing from Cliviger round by Marsden and the neighbourhood of Padiham. He had long known, from his position, of the faults running through the Lancashire field; and one of the greatest benefits to be conferred by the Ordnance geological survey, would be that it would give to the public, at one and the same time, information as to those matters. Hundreds of borings had been made in the district; but each who had bored had kept to himself what he had learned of the strata. He had known in many cases, with the greatest certainty, what would be the result of these borings; but he could not give to the public mining secrets which he possessed. So jealously had the results of the borings been guarded, that constant expense had been incurred in order to settle points which the survey when published would make known to all.

Mr. W. PATTERSON read a paper "On certain markings in sandstones;" and after one from the Rev. C. K. GORDON, "On the laws discoverable as to the formation of land on the globe," the section adjourned at half-past four o'clock, until Wednesday morning.

SECTION D.—ZOOLOGY AND BOTANY.

This section was again presided over at the Royal Institution by Professor Babington.

ABSORBING POWER OF THE ROOTS OF PLANTS.

Dr. JASSEN read a paper on this subject. Dr. Daubeny had established that different species of plants, growing in the same soil, take up therefrom different foods, and contain minerals in different proportions. This selection, it will be said, is made through "vital force,"—a convenient phrase for hiding anything that you cannot or have not inquired into. If we went down to the elementary composition of the living body, the term might be defined as meaning the formation and combination of cells. In this sense it corresponds with, and has comparatively the same range, as the term "crystallising force" as regards minerals. The force that puts together crystals and that which puts together cells, and forms them into living bodies, is equally an unknown force; we use for each the term mentioned. Taking "vital force" to mean the formation and combination of cells, the secretive power of plants was thence to be explained. Some ancient philosophers held that plants desired and selected food nearly in the same way as animals. That opinion was long ago given up; but where is the difference between animals and plants? Men and animals move to food that they want; plants grow for it. This was a point too often overlooked. But animals can move away or cease to take food when satisfied; plants advance their roots amongst their food, and they cannot use the same parts of the same root for obtaining that food a second time. They have, so to speak, to throw out new fibres every time they want food. A sound rootlet took up fluid, whether nutritive or not, in a manner different from an injured one; and many physiologists and nearly all chemists have experimented on wounded plants, without knowing it, owing to the delicate handling which rootlets require. The absorption goes on by endosmosis through the bark cells. Dr. Graham says that by every such process the membrane of these cells is thinned and dissolved; that the endosmosis is different for every different membrane; and that the force of endosmosis is altered not only by the different nature of the substances going into the cell, but also by the nature of the sap in the cell itself. The author considers these facts, as made out by Mr. Graham, to be the starting point of a new era in the physiology of nutrition. No one has yet taken up the matter, and pointed out the value of these discoveries; and it was sufficient at present to point out that Dr. Graham shows that any slight difference in the composition of the membrane, or of the contents of a cell, will be a sufficient cause for a decided difference in the nature of the food introduced into it. The point of a rootlet is of a very different structure from its upper part. It serves only for the growing out of the rootlet, whose cells are formed in the upper part. Many of the cells run into short hollow hairs, which, like the cells, have a very thin membrane. The fluid taken in by the rootlet after a time destroys the outer layer of cells, and the second layer comes into play; but the constant production of new cells in the interior causes the rootlet to increase in size. Passing from cell to cell, the fluid becomes changed into sap; but the sap differs in every cell, and each cell, around one well filled gets out of it a different kind of food. The author contends that it is not possible to get into a plant anything that is a poison to it. The result will be, if poisonous matter is present, that the outer layer of cells will be destroyed, succeeding layers presenting themselves, and also being destroyed, so long as the poison exists around. If the poison gets into the outer cells before they are wholly destroyed, it will not be taken up so readily as nutritious liquid; and in any case, after traversing a few rows of cells, all poison will

be retained, while other portions of the plant will remain uninjured.

Professor ROLLESTON read a paper by Mr. A. Hancock, "On certain points in the anatomy and physiology of the dibranchiate cephalopods."

STRUCTURE AND HABITS OF SPIDERS.

Mr. TUFFEN WEST read a paper "On some points of interest in the structure and habits of spiders." His object was not so much to communicate new facts as to show that in the study of the habits of spiders there was very much to interest and much to be learned. It would be a curious question why so many people shudder at the sight of spiders; for their colours were always chaste, and often they were bright and pleasing. Some had a metallic brilliancy; some closely resembled in colour the ground on which they moved. Some, by perceptible internal emotions, were able to change the colour of their anterior pair of eyes, from brilliant emerald green or ruby red to golden yellow, and *vice versâ*. As to their legs, the third pair of the four which are indispensable, is always the shortest; but at present we know nothing as to why in some cases the first pair is the longest, and in others the fourth or the second. The author describes various other peculiarities connected with different kinds of spiders. The males are almost invariably the smaller; and some of the females, three or four times the size of the males, are known to devour the latter during what may be called the period of courtship. The Atypus pilzeri—our only representative of the bird-catching spiders of the tropics—has the jaws so enormously developed, that but for special modifications the creature would be unable to see its prey when immediately before it. In many cases, the affection of spiders for their young is very great. The female lycosæ enclose their eggs in a cocoon, of a leathery consistence lined with flocculent silk. The cocoon is attached by lines to the spinners, and so carried about. After leaving it, the young for some time cling to the hairs covering the parent's body; and they had frequently been mistaken for parasites. Several spiders of the genus theridion form a strong tent for their residence, strengthening it, when bad weather threatens, so that it resists both rain and gusty winds. The web of the geometric spider is bestrewn, at regular intervals, with glittering beads of a viscid substance, the number of which may safely be computed at 120,000 in a web that would be completed in fifteen minutes. One species, an air breather, lives under water, constructing and carrying down its own diving bell, so to speak. All have a power of restoring lost limbs; and their power of enduring hunger is very great, the author knowing a case in which the fast was continued for 14 months. One point connected with spiders has a curious bearing upon questions raised by Darwin in his "Origin of Species." A few months ago it was publicly stated that spider webs occurred in the abandoned workings of the Pelton Colliery, near Chester-le-street, Durham. The producers proved to be neriene errans, a small spider found, but not abundantly, in hayfields. They were probably carried down with the provender for horses used in the pit. Naturally, they are solitary and construct no web. In the mine their instincts appear, by force of circumstances, to have been completely altered. The author has seen and handled in the mine a sheet of web 30ft. long by 4ft. 6in. high; for there these spiders live not singly but in great colonies. With these changes in habits, is any change in the structure of the creatures taking place? No dissection of the optic nerves has yet taken place; but these spiders are still highly sensitive to light, dropping rapidly from their web on the approach of the Davy lamp. Here is an opportunity of testing Mr. Darwin's theory. The spiders have not long been underground. Will naturalists to come—the creatures, in lapse of time, becoming blind—be able to trace the progressive atrophy of the optic nerves and multiplication in the number of the spinnerets? The specimens removed from the pit had all died soon afterwards. Had the altered [illegible] pressure [illegible] this, or what other reason could be assigned for the fact? Had we, in short, a Darwinian creation proceeding, all the stages of which would hereafter be traceable?

A good deal of discussion followed the paper.—The Rev. Mr. HIGGINS (Liverpool) mentioned a case, in which, according to his father's testimony, a spider must have remained in a pill-box, in a disused coat, for eight or nine years; but which jumped out as soon as the box was opened and seemed quite lively.—Mr LUBBOCK said he knew that Mr. Darwin was very anxious for a comparison with these spiders from the coalpit and others of the species in their natural state.—Mr. WEST gave various directions for preserving specimens. The Nemea, he said, had spinners naturally, but it never made a web, and only spun a line in sometimes passing from one object to another.

The other papers read were:—Mr. P. L. Sclater, "Remarks on the late increase in our knowledge of the Struthious Birds." Rev. A. R. Hogan, "On Daphnia Schaefferi and other freshwater crustacea." Rev. H. H. Higgins, "On the arrangement of hardy herbaceous plants adopted in the Botanic Gardens, Liverpool." Mr. T. M. Mitchell, "On the migration of the herring." Mr. C. W. Peach, "Report on the herring fishery."

SUB-SECTION D.—PHYSIOLOGY.

Dr. J. DAVY presided in this section, which again met in the Gallery of Ancient Sculpture, at the Royal Institution.

A METHOD OF CRANIOMETRY.

Dr. CLELAND read a long paper "On a method of craniometry," with observations on the varieties of the human skull. He said that, notwithstanding the great interest which attached to the changes which the form of the human skull undergoes in the passage from infancy to old age, and the varieties of its appearance in different nations, little had been done as yet to determine what the various superficial appearances indicated as to the exact form of the skull. It was as if artistic views had been taken of the brain's habitation from various points but as yet no ground plan attempted. And this apparently resulted from the skull being studied rather as an object of physiognomical interest than as an anatomical structure. He then pointed out the method which he had invented for making accurate measurements of the relations of any series of points on the circumference of the cranium. The instrument consisted of a framework and bars, by which the vertical and horizontal distance of any spot from a fixed point could be determined. By means of a short series of figures it was thus possible to convey to persons at a distance material for making perfectly accurate measurement of skulls which they had not even seen a drawing of. The reader of the paper then went on to show that, although there was great difference between savage and cultivated nations in the proportional breadth of the cranium and of the face, when the proportions of front, middle, and back parts of the head were examined, there was seen to be no characteristic difference of size and shape between the European and the African. The peculiar appearance of the skulls of Negroes, Australians, Caribs, &c. compared with civilised nations, depended on the way in which the teeth were set, on the development of the frontal ridge to the extent of giving the appearance of a retreating forehead, and on the manner in which the whole head was balanced on the vertebral column. He pointed out that one of the most characteristic differences between man and all other mammals consisted in the fact that the human head was balanced in the erect posture, only requiring muscular action to steady it, while the skull of the chimpanzee and all lower mammals had the head suspended by the action of muscles and elastic structure. To preserve the balance of the human head, it was necessary that a change in the joint which articulated it to the neck should take place in such a manner as to tilt the skull further and further backwards on the vertebral column from infancy to adult age, that the back of the head might be balanced against the increasing weight of the forehead and face; and he de-

monstrated that such a change really took place. Hence also the feminine head, there being a smaller development of the face bones, had a characteristic position in relation to the neck, distinguishing it from the masculinely developed head. He showed that, in the discussions which had lately taken place to such an extent among anatomists, as to the degree in which the cerebellum was covered by the brain proper, in man and in monkeys, there lurked a fallacy; for that in all mammals the anatomically superior aspect of the cerebellum was separated from the cerebrum by the tentorium only; that the real difference lay in this, that the human skull was much more curved upon itself in man than in any other animal. Thus, if the back of a sheep's skull were placed in the same position as the back of a human skull, situated as in the erect posture, the nose of the former would be directed perpendicularly upwards.

THE INFLUENCE OF THE SEASONS ON THE HUMAN BODY.

Dr. E. SMITH delivered an address on this subject. His experiments, he said, had been made upon himself almost exclusively; one set having reference to the respiratory system, and the other to the elimination of nitrogen. As to respiration, the amount of carbonic acid evolved varies from day to day and from month to month, but in a definite manner according to the season. There was a tolerably uniform amount of vital action, according to this test, throughout the cold season; about March or April there was an increase, at the beginning of June there was a decline; the decline continued down to the end of September, and so on until the point from which he started was reached. At the highest point, nine or ten grains of carbonic acid per minute was evolved; at the lowest only six or seven grains. The same rule applied to the quantity of air expired, and to the rate of respiration. The rate of pulsation, however, increased as the heat increased—was the converse of the rate of respiration. As to the evolutions of nitrogen, the conditions were the opposite of those of the elimination of carbonic acid. The experiments had shown that on the very day of a sudden increase of temperature, there was a large decrease of vital action. Difference of season made a difference in the effect of a given degree of heat upon the body. In early summer, high temperature did not affect us so much as later, because then the ground was fresh and cool. The elimination of urea was proved to be direct in degree according to the pressure of the air; with reference to carbonic acid the effect was inverse. It might be at once inferred that the greatest growth of animals would occur at the period of largest amount of vital action; and in this point the animal and vegetable kingdoms were alike. He had been informed, and could well believe, that children grew more in summer than in winter. A late calf or a late brood of chickens was always stunted, compared with those born at the natural period; and this was closely connected with the question of the degree of viability of animals born at different seasons of the year. It was a fair probability to assume that the young of animals born at the period of least vital action, would have less power of resisting adverse circumstances than those born at the period of greatest vital action. He had obtained from the Registrar General means of testing the point, as regarded 3,000 or 4,000 children born in the northern part of the kingdom; and he found that of those born at the later period of the summer, a much larger number died than of those who were born during winter or spring. It was fair to infer, therefore, that children born in the latter period were in all probability less liable to disease than those born during the former. In the conditions which he had stated would he thought be seen both the origin of disease and the origin of the cure of disease—he meant diseases of a chronic character. All epidemic diseases occurred at the period when the human system was shown to be decreasing in vital action, and were at their highest point when the vitality was least. Look at cholera. There may have been some isolated cases during the winter; they may have increased during the spring; but it was always at the beginning of June when their number attracted attention. As heat advanced, so mortality increased; in August or September the greatest mortality always occurred, but the disease decreased in October, and disappeared in November.

The PRESIDENT said he believed that, as a rule, high temperatures agreed well with young children.—Dr. SMITH said that it was not settled when the period of greatest vitality occurred in tropical climates; and as to English children, they generally had to be sent home from the East or West Indies when seven or eight years old.—Dr. NOBLE asked whether the proposition of Dr. Smith, as to carbonic acid gas, was not very much a question of the oxygen inspired. In Summer, the atmosphere was more rarefied. Would there not then be systematically less oxygen inspired?—Dr. SMITH said that it was necessary to go much deeper; for the quantity of carbonic acid diminished, as the quantity of air increased.—Mr. RANSOME and other gentlemen spoke briefly; and the discussion was then closed.

Professor ROLLESTON read papers "On the anatomy of pteropus," and "On the homologies of the lobes of the liver in mammalia."—Dr. RICHARDSON contributed a paper "Physiological researches on the artificial production of cataract."

THE PHYSICAL AND PHYSIOLOGICAL PROCESSES INVOLVED IN SENSATION.

Dr. J. D. MORELL read the following paper on this subject:—Everyone knows that when an appropriate stimulus is applied to any of the organs of sense, a feeling is produced in the mind which is termed, in the language of mental science, a sensation. A pin driven into any of the nerves which extend themselves immediately under the surface of the skin produces pain,—a ray of light falling on the retina produces vision,—a sapid substance put into the mouth produces taste, and so forth. Now it has always been a puzzle amongst mental philosophers to understand, how it is that we can come to a consciousness of external objects at all. Theories without number have been formed, from the time of Plato downwards, to bridge over the gulf which lies between matter and consciousness, between objects of sense around us, and the fact of sensation within us. The chasm in our knowledge we do not pretend wholly to fill. At the same time, so many facts bearing on the question have been brought to light by the progress of physical science on the one side, and by physiology on the other; and so much has been added by the mental analyist, likewise from his peculiar point of view, that the distance between the outer world and our own inner consciousness has been vastly diminished, and the mystery driven back to that one point of connection between the brain and the human soul which no analysis appears likely fully to solve. Let us attempt then to strip away all that is mixed up with sensation naturally, and all that is added to it by our subsequent mental activity, so as to analyse the bare fact itself, and reduce it to its simplest elements. Looking to the physical and external parts of the process, we must consider, first of all, what it is that the nerves convey from the world without to the mind within. Let us take as an example the sense of hearing, as presenting the greatest degree of simplicity. We know, from the investigation of physical science, that the sole medium of sound is the atmosphere. Where there is no atmosphere, there can be no sound, and where the atmosphere is perfectly still, perfect silence is the necessary result. The real cause of sound, therefore, externally considered, is found in the motion of the atmosphere; and the variations in the acuteness or gravity of sound, we know by experiment, arise from the greater or less rapidity of the oscillations. The deepest note which the human ear appears capable of perceiving as a continuous sound, is that produced by sixteen oscillations in a second; the acutest that which is produced by about 48,000 oscillations in the same time. The differences in the quality of sounds arise in like manner, from the peculiar way

in which the atmosphere is affected by the object that sets it in motion, and the corresponding peculiarity of the atmospheric waves that reach the ear. What we really *sensise*, therefore, through the ear is simply the motion of the atmosphere, and nothing more. The human ear is an apparatus beautifully formed for receiving the vibrations on which all sound depends, and the auditory nerve conveys them, in some manner, to the sensorium. With regard to the way in which this latter effect is brought about, we have as yet very little insight. The soft texture of the nerves, and the manner in which they are embedded in the surrounding materials, would naturally suggest a total inaptitude for propagating vibrations in the ordinary sense of that term. It seems more probable that the flow of life through the body is accompanied with a constant thrill and movement in every part of the nervous system, forming what is technically termed the cœnœsthesis, or common sensibility, so that the outward oscillations do not so much originate wholly new vibrations as enter into conflict with the nervous action already going on, and give it that peculiar determination which is necessary to create any given sensation in the mind. This is, perhaps, as far as it is possible to go in our analysis of the physical process. How the vibration of the air comes into conflict with the living thrill of the nerve, and how the result of this conflict reaches the mind, we are at present unable to comprehend. It is one of those hidden secrets of nature which science has not yet been able to unfold. Turning from the sense of hearing to that of sight, a precisely similar analysis holds good. Here the vibrating medium is not the atmosphere, but a universally diffused ether which is set in motion by what are called luminous bodies. Just as atmospheric oscillations form the external cause, and sound the internal result, in the case of hearing, so in sight the oscillations of the light-bearing ether form the outward condition, and colour, in all its various shades, the inward result. Here, accordingly, as before, it is simply motion in nature giving rise to motion in the nerve-world with which we have immediately to do in vision; while, to keep up the analogy, it is the difference in the rapidity of the oscillations that creates all the infinite variations of hue. The red rays, it is calculated, require 458 billions of oscillations in a second, the violet rays, 727 billions, and all the other colours and shades of the spectrum some intermediate number. That the phenomena of sound and sight spring physiologically out of particular states of the corresponding nerves is clear from the fact that pressure on the eye or any artificial irritation, produces the perception of light as strongly as the normal impulses derived from the vibrating ether, and that any artificial excitement of the auditory nerve will produce noise in the head. Ghost-seeing often arises in the same way—that is, when the conditions of sight are brought about by the nerves being affected through some other than the ordinary and legitimate stimuli. Whatever, in a word, can affect the regular vital movements of the nerves and put them into a condition at all similar to that produced by the proper external stimuli of sensation, will, of necessity, bring about similar phenomena of consciousness. We come next to the sense of feeling. This sense comprehends two apparently distinct series of sensations, namely, those of touch, properly so called, and those of heat. With regard to the latter, it has been pretty well established that the phenomena of heat originate in the oscillations of a subtle fluid similar to that of light. The sensation of heat may, therefore, be brought under the law of motion just as much as that of light or hearing, and may be regarded in every respect as analogous. The phenomena of touch, we know, are produced by impact in various ways; and it is just in accordance with the nature of that impact, whether harder or softer—more rapid or more slow—that the resulting sensations are determined. A blow is a sudden affection produced by the rapid motion of some object against a considerable surface of the body. Pressure is a more continuous affection of the same kind. A prick is the motion of some object against one minute point of the skin. If the act of pricking be repeated rapidly, it produces a feeling of burning, and, if it be very soft, at the same time of itching. An extremely light and gentle motion over the body produces tickling. In every instance the peculiar kind of sensation is determined by the nature of the motion and the consequent impact. The only two senses left, accordingly, are those of taste and smell. In both these cases the process by which the nerves are affected is of a chemical nature. The substances received upon the surface of the tongue or the internal membrane of the nostril are subjected to the action of saliva or mucus, and, being thus dissolved, produce a chemical action on the nerves, which gives rise to the phenomena of taste and smell. All chemical action, however, arises, as far as it can yet be ascertained, from certain relative movements in the ultimate atoms of bodies, and it is these movements which, in the case of taste and smell, really give rise to the peculiar sensations so designated. One striking proof of this is, that a similar atomic action can be produced by magnetism, and that various tastes, particularly that of phosphorus, can be produced by the introduction of magnetic plates into the mouth; thus most obviously proving that the phenomena of taste are really produced, like those of heat, by the motion of certain minute particles, whether of some magnetic fluid, or of anything else, when subjected to chemical action. By these atomic movements the nerves are affected, just as they are affected by the infinitesimal oscillations of light and heat, so that the same law holds good throughout, and thus enables us to connect the phenomena of sensation universally with motion as its immediate external antecedent and exciting cause. Looking now from the physical side of sensation to the mental, we shall find that the view we have just taken solves or dissipates many of the difficulties in which the question has always seemed to be involved. First of all, it makes the external cause and the effect upon the nervous system quite homogeneous. Outward motion is the cause, inward motion is the effect. Instead of having the solid forms of the outward world standing as it were face to face with the nervous energy, and being obliged to consider how it is possible for two things so entirely heterogeneous to come into so close a state of mental action and reaction, we have now the whole problem reduced to two developments of motion—first, motion in the fluids around us; and secondly, a certain determination given, by their means, to the atomic movements or vibrations of the nerves. How the movements of the nerve-force are converted into those of mind force, we cannot say any more than we can explain how it is that mechanical motion is converted into heat or *vice versa*; but the outward phenomena are traced in the way we have now indicated, as far back to the inward consciousness as seems possible, without breaking through the last film of separation that divides the conscious from the unconscious world. Secondly: The theory we have adopted enables us to draw a clear line of separation between sensation (properly so called) and all the subsequent mental phenomena which attach themselves to it. Thus, taking the sense of hearing, we can now easily strip away every possible association which connects itself with what we hear and understand, that the sensation of hearing itself simply implies the nervous effect of certain atmospheric vibrations, and nothing more. Taking the sense of sight we can at once negative the possibility of sensizing size, shape, thickness, distance, or any other of the properties of bodies; all we see sensationally is colour, as being the direct result in the consciousness of the luminous vibrations which effect the optic nerve. And so in like manner does every sense confine itself to one single and peculiar series of phenomena, which are not by any means to be confounded with the mental acts and associations afterwards connected with them. Thirdly: The same theory introduces unity into the entire sphere of sensational phenomena. The whole of these phenomena are reduced to the single principal of motion, as the invariable antecedent; this motion, as it exists in external nature, exciting a corresponding action in the nerves, and, then, through the nerve-force, affecting the mind. Thus, then, we find,

by the combined aid of physics and physiology (1), that man possesses a nervous system pervaded by a force which can pass freely from every point in the human system to the centre, and from the centre to every point in the circumference; (2), that he is placed in a universe palpitating with countless millions of vibrations, of which vibrations the nerves of the different sense-organs are directly susceptible; (3), that the whole connection which the mind has, or can possibly have, with the external world, is formed by the motion of the fluids around us, or the motion of the particles of bodies that come into chemical contact with the nerves; (4), that the material universe, therefore, makes itself known to us entirely through the medium of motion; (5), that this motion expresses itself in the nervous system by modifying the regular vital action which is always going on there; and (lastly) that this modification of the nerve-force manifests itself to our consciousness in the varied phenomenon of what we term sensation. Thus the world communicates with the consciousness wholly through motion as a link of connection, and out of the experiences thus formed our whole intelligence is subsequently built up by the laws of mental development.

SECTION E.—GEOGRAPHY & ETHNOLOGY.

The proceedings took place in the Lecture Hall of the Mechanics' Institution, under the presidency of J. Craufurd, Esq. the chairman of the section.

GLACIAL MOVEMENTS ON THE NORTH-WEST COAST OF AMERICA.

The first paper, read by Sir EDWARD BELCHER, was entitled "Remarks on the glacial movements noticed in the vicinity of Mount St. Elias, on the North-west Coast of America." Early in September, 1837, Sir Edward's expedition ran down the coast of North America between Ports Etches and Mulgrave, in order to fix the position and determine the height of Mount St. Elias. The ice bergs which hung near the coast were much larger than any he had seen in Behring's Strait, and northernly, or off the mouths of the fiords in the vicinity of Port Etches. After a description of the beautiful appearances presented by the icebergs, the author of the paper expressed his belief that in Icy Bay the lower bodies of the ice were subject to slide, and that the entire substration, as frequently found within the Arctic Circle, was composed of slippery mud. In Icy Bay, the apparently descending ice from the mountains to the base was in irregular broken masses, which tumbled in confusion. The motion was clearly continuous. As to the causes which operated in causing the constant displacement of the glaciers, and the protrusion of the bergs to seaward, many theories had been proposed. His (Sir Edward's) impression was that whatever was the intensity of cold under which congelation had taken place, the actual temperature due to the ice was merely that of 32 deg. Fahrenheit, and the self-registering thermometers properly buried in ice or snow, subject even to the very low temperature of 63 deg. 5 sec. below zero on the external skin, only indicated the proper temperature of freezing water. Speaking, however, of the very high latitudes of 66 to 76 deg. with the summer temperature between the 1st June and the end of August, the thaw on the surface of the snow-clad elevations furnished sufficient water to undermine the lower beds of snow ice, and bore a passage to the sea. However firm the crust might be in certain positions, a furious torrent had been at work beneath. They were thus driven to the conclusion that the temperature of the earth must, in some degree, aid in keeping up a temperature sufficiently high to prevent the water hidden from light or the sun's rays from congealing. The advance of vegetation was another proof—the ground willow, saxifrages, mayflower, and many others producing their shoots before light caused the immediate expansion and colouring of the leaf. The earth's temperature acting on the lower portions next to the soil, aided in facilitating the travel or slip of the snows of which these glaciers were composed to lower levels. In all ice formations might be noticed, at the season which followed the period of dry frost, or preceded the spring, a peculiar dryness the result of evaporation of the superfluous water, attended by dense fogs. An ominous cracking was then experienced, which had been misrepresented by some of the first arctic explorers as the breaking of the bolts of their vessels; no bolt was ever traced to have been so broken. He imagined that the soil on which masses of eternal, or eternally-shifting, ice reposed, must be, from never being exposed to the sun's rays, of a loose, boggy, or muddy nature, which facilitated slipping. The undermining facilitated cracking, and the very action of alternate freezing and thawing between the exposed surfaces, serving as aqueducts along the upper portions into which water would flow, must produce compact ice; and its power in that very action was quite adequate, by comparison, not only to remove ice, but even mountains of earth, provided the *point d'appui* be afforded. It was evident with respect to the lower portions supporting Mount St. Elias, and which were subject to a summer heat which ripened strawberries, and was even more oppressive than we experienced in England, with the rapid thaws of the inferior levels, that repeated fracture and avalanches occurred. They must calculate on sudden tremendous concussive force, by the breaking away of whole ranges and precipitating them on the lower strata. It was his opinion that the shocks of the avalanches communicated laterally had produced such fractures as had been noticed in those peculiar pyramidal forms near Mount St. Elias. These fractures opened, were filled by water—which probably froze at night or when the sun was absent, and expansion drove the exterior masses, which were then termed bergs, into the sea. Such was his theory, founded on severe thought, over a period of thirty-five years, under frequent contact with nature in actual operation.

Professor SEDGWICK remarked that the paper was a most able one, and supplied a want which had never before been met.—Captain PARKER SNOW spoke of the value of the paper and its accuracy.

The thanks of the section having been given to Sir E. Belcher, Mr. KINGSLEY, one of the secretaries, read "A letter from Sir Hercules Robinson, governor of Hong Kong, relating to the progress of Major Sard, Captain Blackiston, and others, who are endeavouring to pass from China to the north of India," which was communicated by Sir R. I. Murchison; and one entitled "Remarks as to the origin of the name Italia," by Sir Charles Grey.

THE PEOPLE OF WESTERN EQUATORIAL AFRICA.

A very large audience awaited the reading of a paper by M. Du Chaillu on the above subject. After apologising for any imperfections which might be noticed in his mode of pronunciation,

M. DU CHAILLU said: I doubt whether there is another district of the same size as that I have explored in Western Equatorial Africa holding such a number or variety of tribes, all thinking themselves separate nations, and possessing different names, though many speak the same language or dialect. One of the great peculiarities of most of the tribes is that their villages are intermingled with each other. There is no special landmark assigned to each tribe. Every village squats and settles where the people choose, and every now and then the traveller will be astonished to see a village belonging to a certain tribe far removed from it. The habit of selecting land wherever the people of a village like, is owing to the vast extent of unoccupied territory. The cannibals are the tallest and handsomest of these tribes; in fact, they are magnificent savages. But I have found Fans near the Equator, at the head waters of the Gaboon river, who had not the fine appearance of these mountaineers, and were smaller. They even eat the dead. With the exception of the cannibals, the other tribes seem to be intermediate in stature between the tall and slim Yalof and the tribes of North Africa, and the

small-sized men of the Congo, and of the more southern tribes of that Continent, which, according to the specimens I have seen, are small and ugly, with the exception of the Kaffirs. These equitorial people are well proportioned, not stout, and built as if capable of enduring great fatigue. They may, as a whole, be called middle-sized men. Among the cannibals, the females appeared, in many instances, smaller in proportion than the males. According to the commonly-received notion, the negroes dwelling under the Line, or near to it, ought to be darker than those removed from it. It is a mistake. The countries I have visited do not possess what we should call black negroes, with the exception of the Ashira tribe, which are in contrast with the tribes surrounding them. I have come to the conclusion that the negroes who inhabit a damp and moist country, and especially a mountainous country, are less black, though they possess all the negro's features, than those belonging to an open country, where a dry atmosphere is prevalent. In fact, the equatorial negroes are far from being as dark as the negroes I have seen living near the great desert in the Senegal country. Among the cannibals, but more especially among the Apingi, I have found persons almost looking like mulattoes. Albinos are rather common in the tribes I have visited. The negroes inhabiting the sea shore are a shade darker than those of the interior. The negroes of this part of equatorial Africa do not belong to the lowest type of the western coast. They are superior to those of the Congo, or more Southern African tribes. The cannibals may be considered as among the best blacksmiths in Africa. They make knives, spears, axes, hammers; many of their implements of war are good and beautifully shaped. The cannibals are the only tribes I have seen using the poisoned arrows. The tribes I visited south of the equator possess a loom and weave the fibres of a species of palm into cloth of considerable fineness and tenacity. Among the people of the same tribe, intelligence varies considerably. These negroes possess an imaginative mind, are astute speakers, sharp traders, great liars, possessing great power of dissimulation. In making bargains they are as shrewd as any European, if not more so. In anything that does not require mental labour and forethought they seemed to learn as fast as any among the intellectual races, to a certain point. But I never dared to trust to even my best men the arrangements of preparations for our journey. Though often treacherous they have noble qualities, and are given to hospitality. Food is never bought; the rich and the poor have food enough to satisfy their hunger if food is to be got. The women show great tenderness of heart, especially when one takes into account how harshly they are treated. Many times I have been under great obligations to them when sick, for their kind care over me. These people built houses either with the bark of trees or species of wild bamboos. The houses are small, and there is no other opening than a door, or sometimes two. Each tribe is divided into clans; the children in almost all the tribes belong to the clan of the mother, and these cannot by any possible laws marry among themselves, however removed in degree they may have been connected. This has a very healthful influence. Their habits are filthy, they eat carrion, &c. The Apingi tribe, who feed chiefly on the palm-oil nuts, have many more children than other tribes. Their religious notions are of the loosest and vaguest kind. A universal belief exists in good and evil spirits, in the power of charms, in the significance of dreams. I have come to the conclusion that though these people lay offerings upon the graves of their friends; though they even sometimes shed the blood of slaves on the grave of a chief or that of a father of a family; though they fear the spirit of the recent dead, they have no definite idea as to the state of the soul after death. It is believed that the spirit of the victims join that of the departed. Burial grounds exist only among a few tribes; among many, as soon as a person has died, the corpse is left under a tree and the village is removed to a far distance. Some will believe that a certain man's soul, after he dies, goes into the body of a bird, beast, or gorilla; but ask them concerning the transmigration of souls in general, they will say, "No." They think of the spirit of the recently departed as a vindictive thing, which must be conciliated. They believe in the existence of Abambou, or Ocoucou, and Mbruii, they have other names in various tribes which come near to these; both of which they appear to think have power to do good or evil. These are not represented by idols, but in many villages have houses built for their occupation when tired of wandering, and food offered to them. These two spirits are believed in some tribes to have married two female spirits; they are said sometimes to walk in the street of the village, and to speak. They believe in idols, and each clan and head of a family possesses one. Their idols are believed to have power to keep the clan out of evil, and to be able to foretell events. The greatest curse of these tribes is their belief in witchcraft. Strange to say, though reckless of human life, they have a most terrible and debasing fear of death. Polygamy is prevalent among all the tribes I visited. The people who have access to the goods of the white man have more wives; the richer a man is, the more wives he possesses. Slavery is also an institution of the land, the richer a man is, the more slaves he must possess. A man has a right to kill his slaves whenever he chooses. In some of the tribes, which are fast dwindling down, the children born of slaves are free, but nevertheless do not enjoy all the privileges and immunities of the free blood. There are two distinct forms of slavery, the domestic and the foreign slavery. The slave is the money of the country—the unit, the standard of value. If a man is condemned to pay a fine, or if he has to pay for a dowry, he has to pay in slaves. The domestic slave is seldom sold, unless for crime. The conviction gains ground among philologists, that the people of this great continent belong to two distinct families. The line of separation I believe to be found one or two degrees north of the equator; it seems to be caused by the mountains which I discovered, and which I suppose to cross Africa from east to west. To the south of this line, all the people now known speak in dialects which, though sufficiently distinct, belong evidently to a common family, having a common origin. This is true of all, so far as known, from the northern line I have denoted down to the Cape of Good Hope, except the Hottentots, the Namaquas, and a few other insignificant tribes. The tribes which I mention as speaking the Mpongwe language, seemed to me to be among the finest negroes of Western Africa; many of the women have as small a foot as the smallest possessed by the women of the Caucasian race; their hands are also very small. The other tribes have coarser features, which is probably due to the tattoeing themselves and filing their teeth. The Ashira tribe is an exception. The shape of the heads of the different tribes I encountered varies considerably; the Mepongwes, and those speaking the same language, possess the most intellectual heads. Among the cannibal tribes the sugar-loaf head seemed to me the peculiar characteristic. Many of the African tribes are fast disappearing: their language or dialects will disappear with them.

The CHAIRMAN thought they were never likely to get cotton from Africa.—In reply to Mr. J. A. TURNER, M.P. M. DU CHAILLU stated the natives he went amongst wove grass and fibres, but he could not tell exactly from what tree. Cotton grew wild; and he had seen it manufactured into little bags. The natives made mats in great quantities, some of the patterns exhibiting great taste. The slaves amongst the people were not captured from other tribes, but were people who had been sold for crimes, such as witchcraft.—In answer to the Rev. H. Gray, M. DU CHAILLU said he thought it would be most difficult to obtain cotton from Africa. One chief reason was because the women had to perform the labour, and did as little as they could.—Sir E. BELCHER gave some particulars of his experience of the natives of Africa. The natives on the coasts never manufactured iron into any kind of instrument; that was only practised by those in the interior. He had seen the natives on the coast

manufacture very delicate musical instruments. With regard to the question of cotton, the reason of the failure of all continuous supply was very simple. The rainy season terminated in January; it was only between the months of January and May when the work was performed; and during the interval of summer weather, the tornados would sometimes sweep every atom of cotton from the ground. He expressed his belief in the account given by M. du Chaillu.—The Rev J. A. ATKINSON asked the Chairman's opinion with respect to the varieties of colour amongst the natives of the world—whether climate had anything to do with colour.—The CHAIRMAN would state a few facts, and leave his reverend questioner to deduce a theory. The Malay was yellow under the equator; the native of Australia was black, and also the native of Van Diemen's Land, in 35 or 40 deg.; while the natives of Italy and Spain were comparatively very fair in the same degree of north latitude. The Chinese were yellow in the 18th and 50th degrees, while the Hindoos were black in the 8th and 30th degrees. The Esquimaux within the Arctic circle were just as dark as—or even darker than the natives under the Equator and in Sumatra.—M. Du Chaillu having been thanked for his paper,

The Rev. A. HUME, D.C.L. &c. read a paper "On the relations of the populations in Ireland, as shown by the statistics of religious belief;" the next communication being by Mr. H. Duckworth, F.R.G.S. "On the new route to Western China."

SETTLEMENT OF THE CENTRAL PART OF NORTH AMERICA.

JAMES HECTOR, Esq. M.D. F.R.S. in a paper "On the capabilities for settlement of the central part of British North America," stated that that region extended from Lake Superior to the Pacific Ocean, lying immediately north of the boundary line of the United States, and was drained principally by the river Saskatchawan. A considerable amount of agitation had been employed in Canada and at home, in order to have this country thrown open for settlement; the whole, with the exception of that portion which fell within British Columbia, being under the direct control of the Hudson's Bay Company for the purposes of a fur-trading monopoly. It had been placed beyond doubt, principally through the labours of several government expeditions, to one of which he (Mr. Hector) was attached, that there existed within these territories extensive areas, with good and varied soil, adapted for agricultural colonisation, but which, from their geographical position, were necessarily subject to all the advantages and defects of a temperate continental climate. The winter was long and severe, the spring short and uncertain, and the summer tended to scorch the vegetation. The winter, however, was not more severe than that which was experienced in Canada and elsewhere. Many crops which were readily raised in Canada would not meet with equal success in the Saskatchawan; but all common cereals and green crops had been grown successfully. The depth of the snow was never excessive, while in the richest tracts the natural pasture was so abundant that horses and cattle might be left to obtain their own food during the greater part of the winter; and there was no doubt that sheep might be reared, were it not for the immense packs of wolves which infested the country. These remarks applied more especially to the "Fertile Belt." The Saskatchawan country offered a most desirable field to the settler who was deficient in capital, and who had no desires beyond the easy life and moderate gains of simple agricultural occupations. It was only the difficulty of access to it that prevented its immediate occupation. One route from Hudson Bay, by a broken land and water carrige, was now almost abandoned. A second route was from Lake Superior to Lake Winnipeg, which had the same disadvantages. The third line of ingress, undoubtedly the natural one, passed through American territory, up the valley of the Mississippi river to the Red River settlement, by way of St. Paul's, Crow Wing, and across the low water-shed, which there divided the waters of the Mississippi from those flowing to Hudson's Bay. The progress of the adjoining American settlements was then noticed. In the ragged country which lay between the Rocky Mountains and the Pacific coast, no doubt all the valleys were filled with rich auriferous deposits; diggings were constantly being discovered in fresh localities. The formation of a line of railway through British Columbia would involve great difficulties. Throughout the Saskatchawan country, there were deposits of coal of considerable value, though not to be compared with that which was common in England. Coal of somewhat better quality also occurred at Vancouver's Island; and that colony was a valuable link in a chain of communication with China and the East Indies, by way of a line of route across the North American continent.

AUSTRALIA: RECENT EXPLORATIONS OF MR. MACDOUALL STUART.

The Hon. J. BAKER, F.R.G.S. read extracts from a paper on "Australia, including the recent explorations of Mr. Macdougall Stuart." Mr. Baker gave a rapid sketch of the rise of the colonies of Australia, and the habits of the aboriginal inhabitants. During the last year or two, the amount of gold discovered had rather diminished than increased; and a considerable number of hands were now employed in cultivating the soil who were previously engaged in the diggings. All other exports were gradually increasing, and only population was required to enlarge them to an almost unlimited extent. There were numerous rich mineral deposits, and many places in which cotton might be grown with advantage. There was not a more loyal people under the sun than the Australian colonists. Mr. Baker then gave a few extracts from Mr. Stuart's journal of his last expedition into the interior. After noticing the starting of the expedition, on the 2d March, 1860, and the successive visits to Mount Hamilton, and Beresford, Williams, Milnes, Keckwick, and other springs, the character of the country at the West Neale, Frero, the Stevenson, Mount Humphries, the High Gum Creek, &c.; the arrival of the traveller at a small gum creek under Mount Stuart, on the 22d of April, was referred to, that being found, from observation of the sun, to be the centre of Australia. A tree was there marked and the British flag planted. It was a mistake to suppose that the flowers in that country had no smell, a rose being found with a sweet strong perfume. Subsequent interesting adventures were sketched, and the third unsuccessful attempt of the traveller to make the Victoria river was alluded to, the journal concluding with the arrival of the party at Chambers Creek.—Some discussion took place with respect to several statements which had been made as to the aborigines.

GREAT EARTHQUAKE AT MENDOZA.

WILLIAM BOLLAERT, Esq. F.R.G.S. communicated some interesting particulars respecting "The Great Earthquake at Mendoza, 20th March, 1861." The following are extracts from a letter from Mr. R. Bridge, of Valparaiso, to Mr. Bollaert, on the 30th of June. The catastrophe was treated by all as an earthquake, and in the simple sense of the word it might be classified as such, as the writer found in Mr. Ballaert's work on earthquakes; but he (Mr. Bridge) did distinguish between an earthquake and an internal eruption, the latter having evidently been the case at Mendoza, since its effects had been felt north, south, east, and west of the city—at Valparaiso, Coquimbo in Chili, San Juan (north of Mendoza), and El Rosario (east of Mendoza), each more or less equi-distant. It was deficient in many of the characteristics of the earthquakes experienced in Chili, not having followed a line, no rain having fallen, and difference of time not having been observable. In fact, it appeared to have been simultaneous at all places, to have been an upheaving exclusively at Mendoza, and between that and the Andes. No volcano had, however, been found. The walls of the buildings had fallen as though having been rent in every direction, none indicating any horizontal motion; indeed, had there been any such the loss of life,

estimated at 10,500 out of 12,000, would not have been so great, as the means of escape would have been facilitated by the different fallings.

At the conclusion of the proceedings of the section, Mr. Craufurd, the president, received a vote of thanks.

The section adjourned at half-past four o'clock.

SECTION F.—ECONOMIC SCIENCE AND STATISTICS.

The PRESIDENT (Mr. W. Newmarch, F.R.S.) took his seat at eleven o'clock, when the following gentlemen were on the platform:—Mr. James Heywood, Mr. J. T. Hammach, Dr. Farr, Dr. Strang, Professor Rogers, the Right Hon. J. Napier, Mr. E. Chadwick, Mr. S. Brown, Alderman Neild, Mr. Purday, Mr. J. Shuttleworth, Mr. H. Ashworth, Mr. G. Hadfield, M.P. &c. The attendance in the section throughout the day was much smaller than at the previous meetings, until the close of the day, when the room was filled.

EDUCATIONAL ENDOWED INSTITUTIONS.

Mr. JAMES HEYWOOD, M.A. F.R.S. read a paper on "The inspection of educational endowed institutions." He had recently read to the Education Department of the National Association for the Promotion of Social Science, a paper containing recommendations respecting primary instruction and the better application of educational charities. Since then it appeared that the subject was capable of practical application, and he wished now to treat it in a practical point of view. The first example he wished to bring before the section was the case of the Manchester Free Grammar School, the income of which amounted to £3,000 a year. Mr. Cumin, an assistant commissioner under the Royal Commission, visited the Grammar School, and was assured that the greatest difficulty had been experienced in the lower school, because parents demanded assistance in the case of children who did not know their letters, and took their children away from school whenever they pleased; besides which, the number of scholars was so great that the masters could not teach them in a satisfactory manner, and, as there were no school fees taken, there was no funds to provide another master for that portion of the school. There had been a lawsuit against the Grammar School, and the system had been altered in consequence; but it was impossible to maintain discipline, or to do justice to those children who displayed diligence and attention. Mr. Cumin recommended that, as many of the parents of the poorer boys could very well afford to pay for schooling, their children would be much more benefitted in the ordinary National Schools, and that at the Free Grammar School a pecuniary payment should be made so as to relieve the school of an alms-giving character, and to increase the appreciation of the education given. The change would be one of great importance, and would affect hundreds of grammar schools which, in many cases, were found to be an evil. Another great charity which had been inquired into by Mr. Cumin was the Clarke and Marshall Charity, under which the Mayor of Manchester distributed £2,000 a year in blankets. Of 105 persons who were applicants, Mr. Cumin examined their claims in the presence of the relieving officer, and found in some instances the names were fictitious; in other cases relations had recommended relations; in others, the persons recommended were drunkards, or of bad character; in others, they were in receipt of considerable wages, and unfit objects of charity. Of the 105 applicants, whose recommendation papers Mr. Cumin saw, he found that the applicants had 103 children under ten years of age. He also found that in Manchester there are 39 schools under the inspection of the Committee of Council on Education, and that within the last 26 years these inspected schools had received aid to the amount of more than £32,899, or about £1,255 a year on an average. Mr. Cumin thought that no one who had children should be allowed to share in these dole charities unless he sent his children to school, and that a portion of the Mayor's Charities at Manchester should be annually devoted to the assistance of those local schools to which children of the individuals relieved might be expected to be sent. Mr. Fearon, in his able pamphlet on endowed charities, mentions the case of an important school in an eastern county, in which the master refused to accept a scheme usefully extending the education to be given, and declined any scheme which should prescribe the teaching of anything beyond Latin and Greek. He continued to express his readiness to teach Latin and Greek, but no scholar came; the school was closed, and the buildings fell almost into ruins. Masters of endowed grammar schools, who for the most part have been educated either at Oxford or Cambridge, are commonly not prepared to teach, with scientific precision, any subjects except classics and mathematics, and a revision of the subjects of academical examination for college scholarships and fellowships in the ancient English Universities is highly desirable. Mr. Heywood concluded his paper, as follows:—The Royal Commissioners, in their recent report on popular education, lay down the following important principle with reference to endowed educational institutions:—That "the power to create permanent institutions is granted, and can be granted, only on the condition implied, if not declared, that they be subject to such modification as every succeeding generation of men shall find requisite. This principle has been acted on ever since the Reformation, but it has never been distinctly expressed." Acting on this principle, and adopting, as a basis, the suggestions of Mr. Cumin, an assistant commissioner under the Royal Commission, the following recommendations have been prepared:—That one of the Charity Commissioners should be an Education Commissioner, appointed specifically for that subject. That the Charity Commission should be brought into connection with the system of the Committee of Privy Council on Education. That inquiries into endowed educational institutions, under the Charity Commission, should be conducted, as they are at present, by Government inspectors. That no new education scheme should be passed by the Charity Commissioners, until it has obtained the sanction of the Vice President of the Committee of Council of Education, who is always a member of the House of Commons. That ordinances of the Charity Commission for the improvement of educational charities and for the conversion to the purposes of education, wholly or in part, of charities which are mischievous or useless, as at present applied, be laid before Parliament in the schedule of a bill, similar in form to enclosure bills.

The Rev. W. N. MOLESWORTH was quite sure that the Charity Commissioners required resuscitation. Where there were evils to be remedied, the Charity Commissioners were entirely powerless to remedy. There was no doubt that the public had a right to see that charitable institutions were put on a satisfactory footing. No greater abuse could exist than that an endowed school should be shut up, as was the case with regard to a great number of endowed schools. He knew of a handsome school which was turned into a sawpit.—(Laughter.) There was a large endowment connected with this school, and it was a mere sinecure in the hands of the master who did not choose to give instruction. The endowment in this case was a great misfortune. He would suggest to Mr. Heywood to re-consider the proposition of obtaining the sanction of the President of the Committee of Council of Education to any new education scheme. It seemed to him that in some cases difficulties might be thrown in the way of obtaining desirable measures.

Mr. HEYWOOD said it might be limited to where Parliamentary assistance was required.

The Rev. W. N. MOLESWORTH said it was desirable that greater powers should be given to the Charity Commissioners. A person especially connected with education should be enrolled among the Charity Commissioners, and it should be his business to pay particular attention to the education of the country.

Mr. BRACEBRIDGE having made a few remarks upon the

subject, showing the delays which had taken place in an application made to the Charity Commissioners.

The PRESIDENT said that the subject spoken of by Mr. Heywood was very important. It was lamentable in the highest degree that the large funds connected with endowed schools should, in a large proportion of cases, be applied in so exceedingly unsatisfactory a manner. It was desirable to improve the machinery of the Charity Commission, and especially such an alteration should embrace the subject of education.

Mr. HEYWOOD moved that an application be made to the Charity Commissioners of England and Wales, to provide sufficient means for the classification and condensation of the returns of the accounts sent in to the Charity Commissioners.

Professor ROGERS said that he felt convinced that Mr. Heywood had under-stated the amount of the funds returned to the Charity Commissioners in fixing it at £2,000,000 annually. He had proved in his work on Oxford that the income of the University—an endowed school—was half a million annually.

The resolution was seconded, and carried unanimously. A Committee was appointed to see the resolution carried out, and to place it before the Committee of Recommendations.

CAPITAL PUNISHMENTS.

Mr. H. ASHWORTH read a paper on "Capital punishments, and their influence on crime." Passing from the question of Divine authority, and tracing by investigation the theory of our own jurisprudence in this country, we find that, from time to time, under the ever-varying condition of our people, an adjustment of punishment for offences has been determined in some way or other by human judgment, and, for the most part, the punishment inflicted has been greatly in excess of the magnitude of the offences committed. The extremity of this policy would appear to have been reached in the time of Henry VIII. during whose reign it has been stated that the incredible number of 72,000 persons were executed for the crime of theft alone, besides those who suffered death for treason and other grave offences. So fearful an amount of legalised slaughter, committed on a population so small, was calculated to have had a most impressive effect. And yet what do we find? Sir Thomas More, writing at that period, says, "Although so many were trussed up, a man could not travel from his own home without fear of being either murdered or robbed." It has been represented that Queen Elizabeth expressed her surprise that men would be committing crimes at the foot of the scaffold; and by way of corrective of this gross sinfulness of her people, she gave orders that upon discovery of the offenders they should be hanged without benefit of clergy. During the reign of the Stuarts and some of the Brunswick family, the number of capital offences was gradually increased to the extent of 220, and the pecuniary amount for the stealing of which death was inflicted descended to as low a sum as five shillings. Coming nearer to our own day, the prevailing sentiment in relation to almost all offences continued to rest upon the theory of the legislature, that it was needful to hang men by way of example, in order to prevent others committing crimes. In the year 1786, James Holland, of Kirkham, in this county, was condemned at the Lancaster assizes as a "croft breaker," having stolen 30 yards of cotton cloth, of the value of £3, from the bleach grounds of Mr. Thweat, of Burnden, near Bolton. We will not now remark upon the gravity of the offence. He was conveyed in a cart from the Castle of Lancaster to the town of Bolton, and was executed there on the 18th September, 1786. Such was the avowed purpose and determination that the most should be made of the impressive effect, that the employers of the neighbourhood had their servants and work-people assembled on the spot to witness the spectacle; and upon the following Sunday the Rev. E. Whitehead, vicar of the parish church, improved the occasion by a sermon upon the recent execution. After some remarks deploring "the degeneracy and wickedness of the times," he proceeded to inquire—"In what past period in this nation will the people be found more sunk in vice and pollution than the present?" He then went on to assert that "iniquity abounds, criminals daily increase—rapine and villany are at their utmost summit." Taking a retrospective review of the foregoing exposition of one of the 220 cases in which the extreme penalty of the law might be inflicted, the tariff of liability reduced to five shillings, and a theory of punishments calculated to inspire a terror of crime, how humiliating is the commentary of the reverend Vicar, that "criminals daily increase, and rapine and villany are at their utmost summit." Indeed it could no longer be doubted that there had been existing a grievous misapprehension of what were the most judicious and enlightened means to secure the end designed. Following a disclosure of the notoriously ill success of extreme punishments, a committee was formed in London about the year 1808, to afford assistance to Sir Samuel Romilly, M.P. in obtaining the amelioration of our criminal code; and their exertions were gradually successful. One offence after another ceased to be capital, and a change in our penal code was more and more urgently demanded. Public discussion of the subject brought about the acknowledgment, with all the array of a new discovery, that it was not so much the severity as the certainty of punishment which deters men from the commission of offences. The difficulty of procuring the repeal, or even some mitigation of our antiquated penal statutes, lay with the Legislature, and the character of the obstruction offered will be estimated by reference to a few only of the accounts of the proceedings. In the session of 1810, Romilly succeeded in carrying through the House of Commons the repeal of the law which made it a capital offence to steal the value of 5s. in a shop. The House of Lords threw out the bill by a majority of 31 to 11, and in this majority there were six bishops and one archbishop. From a beginning so inauspicious to look upon, the progress of any salutary change could not be very rapid, and it was in 1833 that Lord Suffield appealed to their Lordships on the following astounding statement:—"I hold in my hand a list of 555 perjured verdicts delivered at the Old Bailey in 15 years, for the single offence of stealing from dwelling-houses; the value stolen in these cases being sworn above 40s. but the verdict returned being reduced by the jury to the value of 39s. only." What was the result of this appeal? A change in the law was effected, and Mr. Charles Phillips, in a remarkable pamphlet on capital punishments, published in 1858, somewhat facetiously informs us:—"It did not amount to a repeal, but to an acknowledgment that man, made in the image of his Maker, had risen in the money market, and thereupon human life was advanced by statute from £2, the sum at which it then stood, to £5, being a rise of 60s. per head." The effect of this change in the law, as might reasonably be expected, was, that in like manner juries had recourse to an exceptional verdict of £4. 19s. Sir Fitzroy Kelly stated in Parliament in 1840, "That a few years before there were nearly 200 capital offences on the statute book; now there were only 14, and that there had been no increase of crime since the repeal." Mr. Hume also remarked, "That in no instance had offences increased in consequence of the mitigation of the punishment; on the contrary, there had been a decrease; so that, in future, capital punishments would be but an unnecessary sacrifice of human life." It will hardly be necessary to offer the remark that the security of property and the good order and general welfare of the community are the great objects of Government;—how gratifying is the acknowledgment that these are now being upheld with greater safety and without involving any sacrifice of human life, even of the meanest of our fellow-subjects. The people of Lancashire do not feel indifference, but, on the contrary, they rejoice with the rest of our countrymen in the mitigation of our penal enactments; and, upon an occasion such as the present, it may be allowable, and not inappropriate, if we close this review of the subject by some brief reference to the effects, as they have been disclosed by the criminal

records of our own county. From a Parliamentary paper, it appears that in the course of 22 years, from 1798 to 1818, both inclusive, there were in Lancashire 153 executions, more than 50 of which were for offences connected with forgery; and let it be borne in mind that the population of the county, in 1801, was only 672,565. In the last 22 years, the population of 1861 being 2,428,744, or nearly fourfold, the number of executions have been reduced to 16, and these for murder only. It may be insisted that any such comparison as that of the number of executions does not afford conclusive evidence of the diminution of crime; and that, if possible, some other data, affording more minute particulars, ought to be adduced in support of this assumption. It is well known that in the early part of the present century there were not in existence the means of collecting the needful information in the same careful manner as is now annually prepared by the county constabulary. In endeavouring to account for the presence or the absence of crime, it will be admitted that the employment of the executioner as a moral teacher has utterly failed, and that the enactment of stringent laws has not prevented the onward course of crime. When we come to consider the conditions tending to crime, it is well known that the harassing effects of poverty have been but too frequently the originating cause. Under a pressure so severe, how hopeless would be the attempt to enforce the conviction that "honesty is the best policy;" whilst on the contrary, every one would admit that the meliorating influence of well-paid employment, cheap food, and command of enjoyment, tends to diminish crime and to exalt the character of a people.

The Right Hon. J. NAPIER said that the legislation of the last session had got rid of the punishment by death in all cases excepting those of actual murder and treason. There was a class of cases such as intent to cause death, but where death did not immediately ensue, and where, heretofore, if convicted, sentence of capital punishment was passed. The same penalty had attached to charges of conspiracy to commit murder; but it was generally found that the public conscience was against carrying out these sentences. Where this was the case it was generally considered better to give up the punishment. Out of 46 cases of conviction for capital offences, 22 had been pardoned. England and Ireland had both been included in this clearance of the criminal code, and they had got rid of a hundred acts of Parliament. In cases where human life had been murderously taken away there was a feeling in the public mind that punishment by death was appropriately carried out. Excepting in such cases, and cases of treason, secondary punishments and reformatory institutions had taken the place of capital punishments, with a view of overcoming evil with good.

Mr. J. HEYWOOD said that with regard to taking away life with *malice prepense*, it was exactly the class of cases where juries exhibited the greatest reluctance to convict; and there was a disposition, where there was the slightest doubt or hesitation, to let a guilty man escape rather than run the risk of hanging one who was innocent. The certainty of punishment following the commission of a crime would have a more deterrent effect than where there was an evident disinclination to convict. His own feeling inclined to imprisonment for life instead of punishment by death.

Mr. ROPER mentioned the case of a man sentenced to death at the last Cheshire assizes, where the victim of violence was not dead at the time the sentence was passed. The sentence of the law was carried out, and the man was executed. He wished to ask the ex-Chancellor for Ireland whether there was not some mistake about the statement he had made?

The Right Hon. J. NAPIER said that the new law did not come into operation until the 1st of November next.

THE RECENT CENSUS.

Dr. STRANG read a paper on "The comparative progress of the English and Scottish population, as shown by the census of 1861."

If some distant and untutored foreigner happened to cast his eye over the map of the world, and were told by some enlightened bystander that within the comparatively small islands of Great Britain and Ireland there resided the elements of a first-rate political power, he would no doubt feel some little surprise at the intelligence; particularly were he, at the same time, informed that within the boundaries of Great Britain itself there was only a surface area of about 57 millions of statute acres. But the foreigner's surprise would be perhaps still greater were he further told, that while the southern portion of the island, called England and Wales, with a surface of little more than 37 million of acres, had a population (as ascertained by the late census, exclusive of the army and navy, and merchant service abroad) of 20,061,725, the northern portion, called Scotland, with a territorial surface of upwards of 20 millions of acres, contained only 3,061,329 inhabitants. Such, however, are the real facts of the case; and those, like ourselves, who are acquainted with the distinctive physical peculiarities of the two portions of Great Britain, will feel little wonder about it. There is, however, a subject connected with this territorial division of England and Scotland, and their distinctive populations which is not so easily understood—we mean the fact, as shown by the census returns of the present century, that there has existed for some considerable time, and particularly of late years, a marked difference in the ratio of the progress of the population within the limits assigned to the northern and southern portions of Great Britain respectively. By a table before me, it appears that the population of England and Wales has, in the course of sixty years, increased to the extent of 10,905,554, whereas that of Scotland has advanced to the extent of only 1,452,909, exhibiting an increase on the part of England and Wales of 119·1 per cent, and on that of Scotland of only 90·3 per cent; and if we merely compare the progress of the population of the two divisions of the island respectively during the last ten years, we find that while England and Wales show an increase of 12 per cent, Scotland only exhibits an advance of 5·9, or about 6 per cent. The question then naturally arises, how can this great and important discrepancy between the rates of progress in England and Scotland, particularly as existing between the years 1851 and 1861, be explained? Has it been occasioned by a different birth and death rate ruling in the respective portions of the island? or is it to be found in a larger proportional rate of emigration on the part of the North to that of the South? And if the latter be the case, what may be the probable causes which have led to that higher emigration spirit? Let us then attempt to discover what has been the actual natural increase of the population in Scotland, as deduced from the excess of births over deaths, since 1851. And here a difficulty meets us on the threshold—the fact that before the 1st January, 1855, there was no public register of births, deaths, and marriages kept in Scotland—and it is therefore only from the latter period that we can obtain any authentic figures wherewith to deal. During the last six years and a half the actual increase of the population from the excess of births over deaths amounted to 260,392; and, assuming that the average annual birth and death rates then existing differed but little from those existing during the three and a half years that preceded the passing of the Registration Act for Scotland—which rates were, say, birth rate, 3·41 per cent, death rate, 2·08 per cent—then it would follow that during that period of three and a half years preceding 1st January, 1855, the births must have amounted to 346,115, and the deaths to 211,120, showing an excess of births over deaths of 134,995, and which, when added to the excess of births over deaths during the last six and a half years makes a total natural increase of the population in ten years, within the boundaries of Scotland, of 395,387, or at the rate of about 13.6 per cent. It is therefore quite evident, that had Scotland not been subject to the effects of a serious emigration, her population of last census would have amounted to 3,284,129, instead of 3,061,251. If such, therefore, may be taken as a proximate picture of the real natural progress of the population of Scotland, it necessarily follows, considering the

immigration from Ireland into the west of Scotland, that the tide of emigrating Scotch to other countries must have been very great, especially during the last ten years; seeing that in addition to all the Irish immigration—which, however, has not been so large for these four or five years past—there must have gone out from Scotland no fewer than 222,878 persons, being the difference between the natural increase from the excess of births over deaths, and the increase as shown by the late census. According to the returns made to the Registrar General by the Government Emigration Board, we find that during the last two years, the estimated number of Scotch who have emigrated with the knowledge of the said board has amounted to 183,627, leaving 39,251 which must have left otherwise, either to recruit the army and navy abroad, to push their fortunes in various parts of the globe, unaccounted for by the Emigration Commissioners, or, what is more likely, have gone to swell the population of England. That the population of England has been greatly increased from immigration will at once appear evident, when it is stated that in the ten past years the English-born emigrants have amounted to 640,210, the natural increase of her population only exhibits 136,460 more than her ascertained population by the census, showing an unaccounted-for deficiency of 503,740, for which she must have been mainly indebted to Scotland and Ireland. That an emigrating spirit has manifested itself on the part of the Scotch more than the English is certain from the fact that, taking the mean population for the last ten years of each country, we shall find that, had Scotland only emigrated proportionally to England, the Scotch emigrants oughs only to have amounted to about 100,000, whereas the numbers stated by the Commissioners are 183,627. If the emigration from Scotland has thus been so disproportionately great, it may be asked from what particular quarter of the country has this spirit chiefly manifested itself, or, in other words, in what division of the country has the population absolutely shown a decline? It appears from a table, that in twelve out of the thirty-three counties of Scotland there has been, since the census of 1851, irrespective altogether of the natural progress of the population by excess of births over deaths, a diminution of the inhabitants to the extent of 31,825; and as those counties are almost entirely agricultural and pastoral, the fact would seem to indicate that either manual labour was less wanted in these particular districts, or that a better remuneration for labour and industry was offered elsewhere. For a striking contrast to this state of things in the agricultural and pastoral parts of Scotland, we have only to look to the census figures of the commercial, mining, and manufacturing county of Lanark, where we find, in the course of the last ten years, an increase to the population of no less than 101,390! The fact is, the increase of the population is almost entirely limited in Scotland to towns, and to these of the largest kind—the increase in towns being 10.9 per cent, whereas the rural districts only show an advance of 0·9, or not 1 per cent; or, if Scotland be divided into three great divisions, viz. called insular, mainland-rural, and towns, the insular will show a decrease of 3·6 per cent, the mainland-rural an increase of 3·9 per cent, and the towns an increase of 12·9. But, to show still more forcibly the decline that has taken place among those residing in the rural portions of Scotland, it may be mentioned that the small increase stated as occurring in the mainland-rural district of 3.9 per cent, is owing almost entirely to the increased population of the smaller towns situated within the limits of that great division of the country. The leading deduction, then, to be drawn from these dry statistical details is simply this, that there has existed for some time a manifest tendency on the part of the inhabitants of the country districts, and particularly of those dwelling amid the highlands and islands, to quit a land where rural labour was but little wanted, and pastoral care was poorly paid, for other countries where both were in good demand and highly compensated; or for towns and cities, where the hardy and unskilled labourer is almost always sure to find employment. That this emigrating spirit in search of future prosperity has proved as yet as advantageous to Scotland as it has certainly been Ireland, will scarcely be denied, seeing that it increases not only the value of the labour, and raises the condition of those who remain behind, but elevates the position and increases the comforts of those who go away. And although there must ever be felt a pang on the part of a pilgrim family when abandoning for ever the cherished scenes of childhood, even when those are associated with nothing better than the comfortless home of the Highland cottar; still the mutual personal benefit that results from this separation has been generally found to be, to those gone and to those left, well worthy of the temporary pang. Among the immediate causes which have led to the late depopulation of the Highlands and islands and the partial diminution of the inhabitants of the other rural districts of Scotland, we shall only allude, first, to the great enlargement which has lately taken place in the sheep walks and agricultural farms—particularly in the northern parts of the country—thereby diminishing a host of small master graziers, and even smaller agricultural tenants each and all of them without energy and without capital; secondly, to the discouragement given to the continuance of unnecessary cottars idly occupying the country; and, thirdly, to the effects and results of the late Highland famines, which have, alas, too sadly taught the poor and perishing denizens of a country that cannot maintain them, to flee for refuge to one more kind and hospitable. If, however, from the returns of the present census we have been told that the rural portions of Scotland have, with respect to population, remained either stationary or have shown a tendency to decline, it is, at the same time, certain that in the great centre of trade, mining and manufactures—we mean in Glasgow—there has been a most marvellous increase in the amount of its inhabitants. For while at the commencement of the present century that city and its suburbs only contained 83,769 persons, the last census revealed the fact that its population, with that of its new world-increasing suburbs, amounted to 446,395, and which when compared with the population residing on the same territory in 1851, showed an increase of no less than 86,257 during the last ten years, or a rate of 2,395, or nearly 24 per cent. That this increase has mainly arisen from a constant immigration from all parts of Scotland, and also from Ireland, is no doubt certain; for if we assume that the last year's birth and death rates—which were, birth, 3·87 per cent; deaths, 3 per cent—have been the average rates for the last ten years, which we believe is not far from the truth, and that the mean population during the same period may be fairly assumed to have been 403,000, it will then follow that the natural increase, arising from the excess of births over deaths, could not have amounted to more than above 35,000, which, being deducted from the ascertained increase as shown by the late census, proves that the increase of the city and suburbs must have been supplemented by an immigration of upwards of 50,000. That Glasgow, indeed, has been chiefly indebted during the last half century to the immigration which an increase of capital and an active and multifarious industry have induced, cannot better be illustrated than from the facts which our own lately-printed analysis of the enumeration returns of the Glasgow census then exhibited. From these the fact may be gathered that, independent of the many thousand individuals that have been attracted to that centre of Scottish industry from all quarters of Scotland, there were found within the limits of its municipality alone, on the 9th of April last no less than 10,809 native English, 63,574 native Irish, 827 foreigners, and 1,440 colonists, being about 20 per cent of the whole of that population. While Scotland, from its improved, and still improving, system of agriculture and cattle rearing, may feel well content to part with her supernumerary and unemployed peasantry, either to add to the prosperity of her urban seats of industry, or to continue to fulfil the old adage, that in every nook of the world where any good is to be got, that there is to be found a Scot, a rat, and a Newcastle grindstone, she at the same time cannot but feel assured, so long as-

her soil is daily becoming more productive, and her manufactures, mining, and commerce are advancing, and her cities, harbours, and railroads are extending as they are at present found to be, that she is still on the pathway of prosperity, even although the census has truly proclaimed that the progress of her population has only exhibited an increase of scarcely six per cent during the last ten years of her history.

Mr. J. T. HAMMACK, F.S.S. read a paper on "The general results of the census of the United Kingdom in 1861." Mr. Hammack commenced by describing the machinery which had been used for collecting the census in England, Scotland, and Ireland, and the Channel Islands. In England, 30,862 enumerators were employed; in Scotland, 8,075; in Ireland, 5,096 men of the constabulary force, 15 of the coastguard, and 173 of the Dublin constabulary; and in the Channel Islands, 10 superintendents were employed, and under them 200 enumerators. In the United Kingdom, including the superintendent registrars, &c. there were altogether 48,730. In this number was not included the Custom House officers and others employed to enumerate persons in vessels. The proportion of enumerators to the population was much larger in Scotland than in the rest of the country. In England the average number of persons to each enumerator was 655; in Ireland, 1,091; while in Scotland it was 379. To this army of local agents minute printed instructions and blank schedules for distribution at every house were furnished from the central office. From the London office alone the printed papers forwarded before the census day, by post and railway, weighed about 45 tons, which was equal to 4,200 reams of ordinary foolscap paper. In Ireland, besides the usual information as to the numbers of houses and persons, the heads of inquiry were to include the educational status of the people, their religious profession, the number and causes of death, with other details connected with vital statistics. These last items would have been a needless addition to the census, were not Ireland still the only part of civilised Europe not possessing—and judging from the proceedings last session, not soon likely to possess—a system of registration of births, deaths, and marriages. Fortunately in the present tranquil state of the country the men of the constabulary could be spared to carry out these large investigations, and they undoubtedly possessed peculiar qualifications for the task entrusted to them. The want of uniformity between the returns made from Ireland and other parts of the United Kingdom was a drawback to the general utility of the returns in some respects; but all classes had readily joined in affording the fullest information. In this country no motive existed for concealment or falsification of the numbers of the people. There was no suspicion of the returns being used against the public in reference to taxation or military service, as was the case in several of the continental states. The number of persons residing in the British islands on the 8th of April last was 29,058,888. The men in the army, navy, and merchant service out of the country, either abroad or afloat, amounted to 275,900. The total population, therefore, of the United Kingdom, including the Channel Islands and the Isle of Man might be set down at 29,334,788. The male population of the United Kingdom, including the absent soldiers and sailors, was 14,380,634; the female population was 14,954,154; the females, therefore, exceeded the males by 578,520. To every 100 males there were 104 females. The disproportion of the sexes in this country, no doubt, existed long before it was made apparent by the census of 1801, and of late years it had evidently been increasing. It was well known that, in England, of children born alive 105 boys were born to 100 girls, and the proportion was nearly the same in Scotland and in France. The males continued in excess of the females until the seventeenth year, when the number of the two sexes were nearly equal; at subsequent ages the females were always in excess of the males; the change in the proportion being, no doubt, mainly due to a difference in degree of [illegible] posed, to emigration, and to a lower rate of mortality amongst females. The gross population of the United Kingdom in 1801—taking an estimate for Ireland and the islands in the British seas, not then enumerated—might be set down at 16,095,000. In sixty years, an addition of more than 3½ millions had been made to the inhabitants of the country, besides the vast numbers who had left to found and people new colonies in Australia, or crossed the Atlantic to settle in the United States or the colonies of America. For the whole period of sixty years, the numbers showed a rate of increase amounting to 82 per cent, or on an average 1·01 per cent annually. During the first half of the period (1801–31) the rate of increase was more than twice as rapid as in the second half (1831-61). There was little emigration in the first thirty years; whilst the returns of the Emigration Commissioners furnished an account of nearly five millions of emigrants who sailed in the second period. The great seats of manufacturing and mining industry had maintained their rate of increase. This had especially been the case in the group of districts having Manchester for a centre, which had increased to the extent of 274,000 persons since 1851. A vast increase had also taken place in the localities having their centres in Birmingham (187,000); Newcastle (158,000); and Liverpool (106,000). London had increased 44,000, and now contained a population which would soon reach 3,000,000. On the other hand, a decreasing population had generally been shown by the returns from the agricultural districts; but how far this might be traced to special circumstances, such as the diminution of employment consequent upon improved methods of cultivation, and the substitution of the breeding of stock for tillage, and how far to other causes inducing the unskilled labourer to migrate from the country to towns, might form a profitable subject of investigation. An increase of population usually implied increased happiness, but the converse was not equally true, for the inhabitants might decrease without necessarily suffering privation and misery. Great anxiety had been felt on the subject of the result of the inquiry into the religious denominations, which, for the first time, formed part of the decennial census in Ireland. In obtaining these returns the enumerators met with every facility from the clergy and people, and, as only 15 complaints had been made about them, the Commissioners inferred that they were nearly correct. The following were the results in round numbers:—Roman Catholics, 4,512,000, or 78 per cent of the whole; members of the Established Church, 682,000, or 12 per cent; Presbyterians, 588,400, or 10 per cent; all other persuasions, 8,740; the Jews were only 322. The religious persuasions of the army and navy not having been distinguished they were here distributed in proportionate numbers under the several denominations. The total number of Protestants in Ireland was 1,280,000, giving the Roman Catholics a majority of 3,232,000, or about 3.5 Roman Catholics to one Protestant. Even in "Protestant Ulster," there was a Roman Catholic majority of 17,000. A comparison of these numbers with the results of a special census of religious professions taken in 1834 showed that during the generation that had passed since that inquiry, while the population of Ireland had diminished by 2,100,000, the Roman Catholics had diminished by 1,945,000, the numbers of the Established Church (with the methodists) by 130,000; the Presbyterian and other Protestants by 115,000. A new era had happily dawned for Ireland, and clouds which had so long obscured her horizon, were rapidly passing away. Order and contentment prevailed where agrarian outrage and political agitation disturbed the land. Evidences of the increasing material prosperity of the country were seen on every hand, and formed a general subject of congratulation on the occasion of Her Majesty's recent visit to the sister island. It might confidently be anticipated that the census of 1871 would show by figures the effects of social changes now in progress. The islands in the British seas and the Isle of Man had a population of 143,779, or [illegible]

having been resorted to from motives of economy by persons possessing small independent incomes, increased in population at the rate of 18 per cent between 1831 and 1841, and 15 per cent in the following decade; but free-trade measures having deprived them of their special advantages, the numbers had remained stationary since 1851. According to the latest returns and official estimates, the population of the North American colonies was not less than 3,795,000, and that of the Australian group was 1,272,000. For the West Indies they might set down 990,000 on the authority of the well-known blue books. The Cape and other African Colonies contained 870,000 inhabitants; Ceylon, 1,754,000; Mauritius, Hong Kong, &c. 280,000. In Europe—Malta, Gibraltar, the Ionian Islands, and Heligoland contained 304,000. To these an enormous addition must be made for British India, stated by Mr. Horridge, of the India Office to contain (exclusive of the native and foreign states) not less than 135,442,000 souls. Add the population of the United Kingdom, and they obtained what might truly be called a "grand total" of 274,000,000 of subjects of Queen Victoria. Increased intelligence, combined with the new discoveries of science, and the powerful inventions in aid of industry which had sprung up on every side and far above all other causes, the benefits conferred by the steam engine, the railway, and free-trade, left no doubt that the material prosperity of the country, and consequently the number of the people would continue to increase.

Professor Rogers read a paper which had been prepared by Mr. T. A. Welton, entitled "An examination of the increase and decrease of population in England and Wales, 1851-61," and also stated the substance of a paper written by Dr. Bakewell, "On the influence of density of population on the fecundity of marriage in England." Dr. Bakewell's deduction from figures which he quoted, was, unless recruited from the rural districts, the crowded populations of great cities would not hold their own.

Dr. Munro attributed the improvement in Ireland at the present time to the cessation of early and improvident marriages.

The Right Hon. J. Napier said he should be glad if the allusion to the want of registration of births, deaths, and marriages in Ireland made by Mr. Hammach had the effect of calling attention to the subject. He moved the following resolution on the subject:—

That in the opinion of this section it is most important and desirable for Irish as well as Imperial interests that there should be in Great Britain and Ireland an uniform law as regards the registration of births, deaths, and marriages; and that it is further the opinion of this section that it is quite practicable to frame such law with due regard to religious persuasions of the majority of the Irish people, believing that there is the fullest disposition on the part of the majority to further any measure beneficial to Ireland.

The discussion was continued by the Rev. W. N. Molesworth, Dr. Farr, Mr. Swallow, and Mr. Alderman Neild.

The President hoped that in the next census they should have returns for England in three important elements upon which they were now without information. He referred to the religious professions of the people—(hear, hear)—the quantity of land under crop, either at the time of the census or at the preceding harvest—and the quantity of live stock, such as horses, cattle, sheep, and pigs. He hoped by the next census the people of this country would have got rid of their superfluous prejudices, and consent to returns under these heads.

GOVERNMENT SCIENTIFIC EXAMINATIONS.

A paper by Captain Donnelly, R.E. was taken as read. Its subject was "The aid now granted by the State towards the instruction of the industrial classes: its nature and results."

The subjects, towards instruction in which aid was given, are:—Geometrical drawing, including practical plane and descriptive geometry, mechanical and machine drawing, and building construction; mechanical physics; experimental physics; chemistry; geology and mineralogy; animal physiology and zoology; and vegetable physiology, economic and systematic botany.

LIVERPOOL NATIONAL SCHOOLS.

The Rev. Dr. Hume read a paper "On the condition of the National Schools in Liverpool as compared with the population of 1861." A long discussion followed the reading of this paper, in the course of which an opinion was expressed that the system of giving government aid in proportion to local exertion acted prejudicially to the poorer districts of a city."

THE GOLD DISCOVERIES.

Mr. H. Fawcett delivered an address "On the economical effects of the recent gold discoveries." He did not at all agree with M. Chevalier, a man who was wonderfully over-estimated, in believing that the value of gold would rapidly decline at least 50 per cent; and he pointed out means of absorption which had, and still would, prevent a decline in the price of the metallic currency.

The President said that the gold in the country in 1848, at the time of the discoveries in California, was 600 millions. At the close of 1860, the quantity which had been added from California and Australia was no less than 300 millions. Of this 40 or 50 millions had been added to the gold circulation of the United Kingdom; 100 millions had gone to France; 80 millions to the United States; 20 millions had been absorbed in Australia; and 20 millions to California; 20 millions had gone to Turkey and the East, and the remainder to Brazil, Egypt, Spain, Portugal, and other countries of less magnitude. Supposing the supply to go on for 20 years, it would be absorbed by the degraded paper of Austria and Russia, by the now firm and free government of Italy, and by the United States.

PATENT LAWS.

Professor Rogers read a paper, in which he asked the question, "Can patents be defended on economical principles?" Professor Rogers contended that patent laws did not stimulate invention; they did not come within the definition of protection to property and the acknowledged duty of the state to maintain intact the labour of individuals; they acted as a hindrance to improvement by being a check on the freedom of beneficial discovery; they were an illogical acknowledgment that the accidental property of discovery was the ground for allowing a sole property. All reasonable advantages were secured by secresy, and were constantly superseded by secresy; and they were a tax in the fullest sense on the consumer.

An animated discussion followed, in the course of which the arguments of Professor Rogers were replied to by Mr. Webster, the Mayor of Manchester, the Right Hon. J. Napier, Mr. Grove, Q.C. Captain Blakely, the Rev. W. N. Molesworth, and Mr. Johnson. The President, having ably summed up, declared the business of the section closed.

The Right Hon. J. Napier proposed a vote of thanks to the President for the very efficient manner in which he had discharged his duties in presiding over that important section. They had sat for a week, and during that time every variety of subject had been brought forward; and they had had the advantage of the skill and masterly ability of Mr. Newmarch. He was one of a class of men who were peculiarly entitled to respect—men who by the self-elevating power of intelligence and vast industry had raised themselves to a distinguished public position, and who stood well with all their well-thinking countrymen—(Cheers.) He rejoiced to see him in the chair, his presidency harmonising so well with the President of the Association, who was the honour, and ornament, and praise of the town—(Cheers). He was sure they would all have the very greatest pleasure in passing a vote of thanks to his friend, Mr. Newmarch for the able, efficient, and instructive manner in which he had discharged the duties of President of that section.—(Cheers.)

The Mayor of Manchester said he had much pleasure in seconding the resolution so ably proposed by the right hon. gentleman. All of them must have derived much pleasure and profit in attending the section; and espe-

cially in listening to the clear and perspicuous manner in which the President had stated the merits of every question which had come under discussion.—(Cheers.)

The resolution was carried amid general applause.

The PRESIDENT, on rising, said: I am very much obliged to you, ladies and gentlemen, for the vote of thanks which you have been good enough to pass for my very humble services performed in this chair. I certainly came to Manchester fully prepared to carry out so far as I could any duties which might fall upon me; and I am glad to find that the way in which those duties have been performed have met with your approbation.—(Hear, hear.) As I am placed in this position, I will take the opportunity in a few words of reviewing what has taken place in this section during the week. First of all I cannot but lament that our time has been insufficient for the task we had set ourselves. We certainly have made some advance upon the arrangements which, as far as I remember, prevailed at former meetings of this section; and I hope that next year, and in future years, we shall succeed more entirely in confining our labours to such questions as belong properly to economic science. There is less reason why questions of a general nature should be obtruded here since there is a separate association for the advancement of social science, where questions of a more general nature may be introduced with more advantage, discussed with more benefit. But so far as our labours have proceeded, I find that we have got through between forty and fifty papers, which will admit of being somewhat distinctly classified. First of all we have had a series of papers, of a valuable kind, relating to what I may call Lancashire topics. Among these, I will give the first place to a valuable paper by Mr. J. Shuttleworth, pointing out to us the working of the Manchester Gas Act; Mr. Chadwick gave us a great deal of valuable information on the progress made by Manchester and Salford during the last 20 years. It was to be expected that a meeting of the kind held in Manchester could scarcely have been considered effective unless the question of cotton was discussed; and we have largely benefited by papers read by Mr. Bazley and Mr. Ashworth; and we had also a short paper from Mr. Alderman Neild, which was valuable inasmuch as he stated facts of an order which we are not always able to obtain. We had also a paper from Dr. Strang on the embroidery trade of Scotland and Ireland. Also under the head of Lancashire topics we had a valuable paper from Dr. J. Watts, on strikes. We had also a series of papers on co-operative societies, beginning with one by Mr. Potter on the general principles of the question, and followed by two remarkable ones from Rochdale, informing us in a very succinct and clear manner the results of the remarkable experiments going on in that town. The second group of papers were on purely statistical questions. First in this list I must refer to a remarkably excellent paper by my friend Professor Rogers—a paper compiled by him during the last few months with so much labour, perseverance, and skill, and containing a collection of prices in this country in the sixteenth century, the period of the first influx of gold from the New World. I regard that paper as one of the most valuable fruits of the Statistical Congress, and I hope it is but the precursor of many more, and that the example Professor Rogers has set will lead to researches being undertaken and carried on not only in this country, but in other parts of the world.—(Hear, hear.) Dr. Farr gave us some valuable information on the health of the British army—a subject with which he is connected, and upon which he was eminently able to dilate. Then we had a valuable paper from Mr. Purdy on the comparative pauperism of England, Scotland, and Ireland; and we had also an elaborate paper from Mr. Valpy, stating, in a convenient form, facts relative to the trade between this country and France. We have to-day had valuable papers on the census, beginning with that of Mr. Hammach, who comes amongst us speaking with the authority due to one of the chief officials in connection with the operations by which the enumeration of the population has been carried on and completed. We have had also a statement to-day from Dr. Strang of the results of that census as regards the Scotch. The third division consists of questions purely economical. I confess I should have been glad if we could have had more of those papers, and I again repeat the wish I have already expressed that in future years and in other places where this Association assembles—and I think we may fairly assume that Section F will remain an integral part of the Association—(hear, hear)—a larger number of papers, purely of an economical nature—papers raising, as that of Professor Rogers's to-day, purely economical questions, going straight to some great doctrine, the discussion of which must be attended with the utmost possible good. (Cheers.) Foremost in this group of economical topics is the series of papers on national taxation. These papers you all must remember, inasmuch as they were before us only yesterday; but as I had the fortune or the misfortune to take a conspicuous part in the discussion, I may fairly pass them over simply with the observations I have made. As regards special taxation, we had a remarkable paper from the Rev. Canon Richson, which there is every reason to hope will lead to ulterior results.—(Hear, hear.) Under the head of distinctly scientific papers, we had a second paper from Professor Rogers, "On the definition and incidence of taxation;" and an address we have heard to-day from Mr. Fawcett, "On the effect of the new gold discoveries." In the fourth place, on general topics we have heard, this morning, Mr. Heywood on the subject of "Endowed schools;" Dr. Hume "On education in Liverpool;" a short and interesting statement from Captain Donnelly, "On the progress made in the Government examinations in science;" and also a paper by Mr. Ashworth, "On capital punishments;" while yesterday afternoon we were entertained by hearing Mrs. Fison so charmingly in the midst of us dilate "On sanitary reform." Beyond these there were several contributions of a minor kind in themselves, but well worth listening to, raising points which I am sorry the section had not power to discuss as they deserved. The discussions which have taken place have been distinguished, I think, beyond any occasion I can recall in connection with any former meeting, by a degree of earnestness and courtesy, and by an adherence to the point which it was material to consider. They have been distinguished by qualities which I hope will enable every member of the British Association to look back upon them with pleasure. In conclusion, you will allow me to say, that for the success which has attended our meeting here, we owe a deep debt of gratitude to every party connected with the city of Manchester. From the Mayor of the city down to the meanest cabman, I believe there is no single individual throughout this great community who has not felt it as a special moral obligation to do what lay in his power to promote the success of the meeting.—(Cheers.) I, therefore, in your name, and in the name of Section F, tender my best thanks in the first place to the municipal authorities who are represented on this platform by the worthy Mayor of the city. I thank, in the second place, the commercial community for the munificent manner in which they have thrown open their establishments, and for the arrangements they have made for our benefit and amusement. I tender our thanks, too, to the private inhabitants, who have manifested so wide a liberality in throwing open their houses for our entertainment and reception; and in the fourth place, I tender our best thanks to the local committee and the local secretaries, who not merely during the last week, but for a great many weeks preceding the opening of the meeting, have been untiring in their exertions to contribute to our comfort during the meeting.—(Cheers.) In return for all these obligations, I have only to say that I hope the meeting will have been productive of some good, and I hope that the seeds here sown will blossom and fructify at some future time.—(Cheers.) I will only add, as regards myself, that if I have in the least degree contributed to that end, I shall be amply repaid for the labour I have undertaken.—(Cheers.)

A vote of thanks to the secretaries was proposed by

Mr. WEBSTER, and seconded by Dr. FARR.—In responding, Professor ROGERS said that the more they saw of Manchester the more they liked it.—(Cheers.)

The section adjourned, to meet again next year in Cambridge.

SECTION G.—MECHANICAL SCIENCE.

The section met at eleven o'clock, in the Peter-street Schoolrooms; Professor WILLIS in the chair. Two improved cotton gins were exhibited—one by Messrs. Platt, of Oldham, and the other by Mr. Dunlop, of Manchester. The improvements in Messrs. Platt's machine were the application of spike rollers revolving at different speeds, in connection with the vibrating comb which transmitted the cotton to the ordinary churka roller. It was intended to be worked by power. Mr. Dunlop's machine was less expensive, and more compact, bearing a closer resemblance in appearance to the original churka. It was worked by hand. Both machines seemed to do their work remarkably well. A number of models of boats were also exhibited illustrative of steam navigation on the rivers and coasts of India and China.

Mr. P. LE NEVE FOSTER read a report by Professor Thompson on experiments on the gauging of water, which had been conducted in the open air, near to a corn mill, in the neighbourhood of Belfast, and had been entirely successful. The Professor was convinced that the triangular or V shaped notches in vertical plates had a decided superiority over the rectangular notches, with level bottom and upright sides in ordinary use.

DURABILITY OF WROUGHT-IRON BRIDGES AND GIRDERS.

Dr. FAIRBAIRN, president of the Association, presented a paper containing a series of experiments on the effects of vibratory action and long-continued changes of load upon wrought-iron bridges and girders. He said this was a subject of great importance as affecting the construction of tubular and plated bridges, and also the lattice and trellis bridges. Fifteen years ago experiments were made which led to the construction of the Conway and Britannia tubular bridges on the Chester and Holyhead Railway, and determined the form in which such structures should be designed. Since that time some thousand of bridges had been built entirely of iron. The requirement of five tons per square inch on the part of the Board of Trade appeared to be founded on no fixed principle. It was well known that the power of resistance to strain of wrought iron depends very much upon the form in which it is combined, and unless the proportions of the parts were permanently established, the five ton tensile strain might lead to error. For the purpose of making experiments upon the influence of vibration in causing the rupture of beams and bridges, he had constructed a small iron plate beam of 20 feet clear span, and 16 feet deep, representing the proportion of one of the girders of the Spey Bridge, and exposed it to conditions similar to those of a bridge subject to changes of load as produced by the passage of trains, and in proportion to the heaviest rolling load. The beam was first loaded to one fourth of its breaking weight, and it sustained a million changes of load without injury. The load was then increased to nearly one half the breaking weight. With this weight the beam gave way, after 5,175 changes. It appeared, therefore, it was not safe to build bridges in which the rolling load would bear this proportion to the breaking weight. The beam was taken down and repaired, and the experiments were then renewed. The load was then reduced to two fifths the breaking weight, and 25,900 changes of load were sustained. Lastly, the load was reduced to one third, and the experiments were still proceeding, the beam being uninjured after 2,727,754 changes. In calculating the strain upon the area of the metal after deducting the rivet holes, which it must be remembered were larger in proportion in this small beam than in bridges, he found that the beam would sustain no deterioration with strains of nearly 7½ tons to the square inch. With ten tons to the square inch the beam broke after 5,172 changes. Now, as the limit of elasticity was reached at about 9 tons per square inch in ordinary boiler plates and bridge plates, it would appear that it was unsafe to load structures subject to a continually varying load beyond that point. Within those limits, however, there was no evidence that a deterioration of structure took place. On some future occasion he might have again to refer to this subject. For the present, he would advise that in all beams and girders, tubular or plain, the permanent load or weight of the girder and its platform should not, in any case, exceed one fourth of the breaking weight; and that the remaining three fourths should be reserved to resist the rolling load in the proportion of six to one. As a general rule, these ratios of strength would apply to all bridges; but the strain would be least on the smallest bridges, which, in his opinion, was requisite on account of the frequency of neglect of smaller structures. He earnestly directed attention to the laws which governed the resisting powers of girders exposed to transverse strains, to the best principles of uniting the joints, and, above all, to the selection of the best material, which, in the parts of the girders subject to a tensile strain ought always to sustain a test of from 22 to 24 tons per square inch. The use of superior metal for the bottom of the girders would give an increase of from one fifth to one sixth in the strength. There was no economy—and he wished particularly to impress this on the section—in the use of inferior iron for this purpose, and its employment inevitably led to a loss of character in the structure, and danger to the public.—Mr. OLDHAM moved that the paper just read should be recommended to the Association to be printed in extenso in the minutes. This motion was seconded by Mr. C. Vignoles, and was carried unanimously.—Lord WROTTESLEY expressed his satisfaction that Mr. Fairbairn, with that public spirit which characterises him, was continuing those experiments which the Iron Committee of whom he was chairman had commenced, but which they were not able to continue, through the discontinuance of the government grant.—Dr. FAIRBAIRN said he was glad to state that the Government had acted in a more liberal spirit to himself, and had granted £150 to conduct the experiments.—Mr. CAWLEY said if he understood Mr. Fairbairn's experiments rightly, the vibration to which the beam had been subject was continuous. He believed, and in the case of steam boilers he knew, it was the case that the fractures more often occurred when percussion took place during the period of vibration and when one wave of vibration came in contact with another. He suggested that Mr. Fairbairn should make experiments as to the effects of irregularity of vibration which would often have to be encountered in the case of a railway bridge.—Mr. FAIRBAIRN remarked that the extra vibration to which he had subjected the beam would almost meet this condition.

THE IMPROVEMENTS IN COTTON GINS.

Mr. DAVID CHADWICK, secretary of the Manchester Cotton Supply Association, read a paper "On recent improvements in cotton gins." A description was given of the old Indian churka, one of which was exhibited to the meeting, and the invention of the American saw gin, by Eli Whitney, was also noticed and described. On the recent visit of Dr. Forbes, the superintendent of the cotton gin factory of the late East India Company, to Darwhar, he introduced an improved cotton gin, based upon the principle of the Indian churka. This churka gin had subsequently been improved by Mr. John Dunlop, of Manchester, and Messrs. Platt Brothers, of Oldham, and the improved machines were now exhibited to the meeting. They would be submitted in the same way as other cotton gins to competent arbitration.—Mr. T. BAZLEY, M.P. said the machines before them were wonderful improvements on the old churka. He noticed the destruction of fibre and the waste occasioned by the American saw gins, and said he had seen

cotton in the market selling for 7d. per lb, which, if cleaned by a roller gin, would have sold for 2s. per lb. The injuries inflicted upon the raw cotton were not so great as upon the long fibre cotton, because the teeth of the saws allowed the short fibres to go through without severing them. During the last few years, an improved kind of roller gin, known as the Macarthey gin, had been introduced into America. An intimate friend of his had obtained one of these gins, and placed it in the hands of Mr Dunlop, who had made a large number of these gins, which the Cotton Supply Association had forwarded to the various cotton producing districts of the world. But when he turned to the machine which had been constructed by Mr. Platt, that appeared to him to be the machine best adapted for the cleaning of a very large quantity of cotton in a short time without injury to the fibre. He was very glad to see these machines in the room, though he feared they should soon be in the position of the cook who had all the appliances for cooking a good dinner, but was without the mutton and the beef to cook. He was afraid unless very serious efforts were made, this great industry of theirs would be very much depressed.—Mr. ASHWORTH said he believed the Indian cotton, which, as now cleaned, was worth 4d. per lb, would be worth 5d. per lb, if cleaned by the cotton gins exhibited.

THE EXTINCTION OF FIRES.

Mr. J. F. BATEMAN, president of the section, made a verbal communication respecting the best modes of extinguishing fires. He had hoped that a paper would have been read on this subject by Mr. Rose, of the Manchester Fire Brigade, but as that gentleman had been called away by the illness of a relative, he (Mr. Bateman) thought it right that the proceedings of the section should not terminate without some observations being made on the subject. Nothing could have been much worse than the arrangements made for the extinction of fires some fifteen years ago, and nothing could be much worse than the state of things which existed at the present day in the city of London. In most large towns, as Manchester and Glasgow, for instance, where the supply of water had been taken into the hands of the Corporation, the best preparations had been made for the extinction of fires. But in London the fire engines and the brigade were maintained by contributions from the different insurance companies, and it was therefore evident that their interest only lay in preventing the destruction of property that was insured. It was clear this was a state of things which ought not to exist in this country. Some 12 or 15 years ago he turned his attention to the subject of the extinction of fires. The old wooden plug or fire cock was then generally in use, and it still continued in use in some parts of the country. Mr. Bateman described the construction of the branch stand pipe, with which he had replaced the old plugs in Manchester and other towns, and stated that as a general rule these stand pipes had been found sufficient without the use of fire engines. He also explained the principle upon which the water pipes were laid down in Manchester; so that within reach of nearly every block of valuable buildings in Manchester and the neighbourhood there were from two to three sources of water supply, and ten or twelve fire cocks within a hundred yards. Then came the question of pressure. It was popularly supposed that water could be thrown to any height; but this was not so. About 80 or 90 feet was the greatest height water could be thrown by a fire engine. In Manchester during the day, when the demand on the water supply was greatest, the pressure was diminished about six feet per mile. The highest mills in Manchester were from 40 feet to 60 feet, and experiments had been made to show that at the low pressure the largest stand pipes would throw 90 feet. With the smallest stand pipes, four inches in diameter, the height varied from 33 feet to 90 feet. Experiments had been made in the Town's Yard, which had shown that with large engines, requiring thirty men to work them, with constant relays, no advantage was gained over the stand pipes, which required but two men to work them. He now wished to draw their attention to the arrangements which ought to exist for the extinction of fires. If once the flames had obtained a hold of the building it was utterly impossible to extinguish it, and all the water poured on became at once converted into steam and thus increased the draught, and only served to add fury to the flames. All the fire brigade could then do was to prevent the fire from spreading to the surrounding buildings. And yet if a bucket of water had been applied at the right time, the fire might have been prevented. Therefore, what ought to be done was that in every district a fireman should be stationed within a distance of not more than 100 yards from the scene of a possible fire. Manchester was divided into 17 districts, in each of which districts a waterman was stationed, whose duty it was to make himself master of his own district. Of these 17 men 10 belonged to the fire brigade, which consisted altogether of 50 men. Now if in addition to these watermen other members of the brigade were stationed in various districts, each man furnished with a small hand cart, a stand pipe, and as much hose as he could carry in his hand cart, and was also enabled to communicate by telegraph with the central stations, the frequent recurrence of serious fires would be in a great measure prevented. He did not think there would be either any difficulty or any great expense in carrying out this arrangement. Under present arrangements a fire might occur two miles from the principal stations. A person would consequently have to run that distance to give information, ten minutes would be occupied in this way, it would take ten minutes more to get the horses out, and some further time would be consumed in arranging the hose. Perhaps during the time thus lost the fire would have made such headway as to be beyond the power of extinguishing. He was satisfied that if the plan he proposed were carried out it would pay for itself in many ways.—(Applause.)—Mr. W. SMITH said he thought too much attention could not be bestowed upon the way in which water was thrown on to a fire. He had seen water thrown in such thin jets that it was at once converted into steam. He thought it should be thrown as much as possible in lashes, in a body.—Mr. ADAMSON suggested that instead of the water being thrown so much to the top of a burning building, it should be thrown on at the bottom, so that the steam should assist in extinguishing the flames above.—Dr. ROBINSON called attention to the beautiful system of telegraphing in use in America in the case of fires.—The CHAIRMAN remarked that their next paper would bear upon this subject.

Mr. C. W. SIEMENS explained a system of telegraphic communication adopted in Berlin in the case of fires, by means of which immediately after a fire occurred the police at every station in the town could be informed of the occurrence, and of the district in which the fire had occurred. He said it was found by the adoption of this system that the fire engine was generally on the ground five minutes after the alarm had been given. He also explained and exhibited a system of railway signalling extensively adopted on the continent, which rendered collisions almost impossible.—A GENTLEMAN in the body of the room stated that he had many years ago made a proposal to introduce a system nearly identical with that first described by Mr. Siemens into the city of London, and recently a committee had been appointed with a view to its adoption.—The PRESIDENT said he was glad to hear anything good of the city of London, for his experience was that the authorities of that city were the most impracticable body in the country.

Colonel Sir HENRY JAMES, R.E. laid before the section information as to the process of photo-zincography or the process of copying ancient documents by means of photography, and transferring them to zinc. He exhibited the copies of portions of the Doomsday Book, the Chronicle of St. Swithin, and other ancient chronicles made by means of the process, and also exhibited some copies of

the ordnance survey made with great accuracy and remarkable cheapness by the system of photo-zincography.

Mr. HAWORTH read a paper explaining his patent for improvements in street railways by the addition of a fifth or perambulator wheel to the carriages. It was calculated that a saving of 35 per cent would be effected by this plan.—Mr. VIGNOLES expressed his opinion that if any street railway were ever adopted, Mr. Haworth's system would be the one. He had never seen a more promising system.

It was stated that Messrs. Silver had on view a telegraphic wire, which was impervious to the influence of the atmosphere.—Mr. HIGGINS explained his system of sledge brakes, and referred to the model exhibited in the Free-trade Hall in explanation.—The meeting was also referred to the model of Mr. Peter Effertz's brick-making machine, also exhibited in the Free-trade Hall, and the principles of which had been approved by the Mechanical Section. A paper was contributed by Mr. Malm, superintendent of the Museum of Gottenburg.

The PRESIDENT announced that there would be an excursion to the Manchester Waterworks on Thursday, under the conduct of himself.

The section then adjourned until the meeting at Cambridge next year.

NATURAL HISTORY SOIREE.

In the evening a soirée and a fine exhibition of botanical and zoological specimens, contributed by members of the Manchester Field Naturalists' Association, took place at the Free-trade Hall. Ranged down the centre of the room on two long tables were a variety of most beautiful and interesting objects of natural history. The collection of insects was remarkably good, including no less than 14 drawers of melitophilæ, contributed by J. A. Turner, Esq. M.P. vice president of the Society. This collection is stated to be the finest private collection of the kind in Europe, and, probably, the finest in the world. It comprises several specimens of the goliathus magnus, of which extraordinary insect the members of the Association on their first visit to Manchester, in 1842, were shown the first and only specimen which had then been brought to England. Mr. Turner also contributed a most interesting case of 100 insects, chiefly new, collected by Dr. Livingston in the Zambesi district, in 1860, and a fine collection of British birds' eggs. Amongst the other contributors to this class were Messrs. Harrison, Sidebotham, Watson, Edleston, Linton, Kenderdine, and Carter. In the botanical department, Mr. Grindon furnished a series of specimens illustrating the progress of vegetable development. Thus, germinating seeds were shown in three different stages of development, and then followed oak, walnut, chestnut, and filbert trees of the present year, with the seeds still clinging to the feeble rootlets. The concentric rings in the stems of exogenous trees, such as the laburnum, cedar, and cork trees, &c. each of which rings indicates a year in the life of the tree, were shown by horizontal and vertical sections. A great number of rare and curious fruits and seeds, chiefly foreign, had been forwarded from the collections of Messrs. Grindon, Coward, Norris, Holland, and other members; and other productions of interest and rarity were exhibited. Round the walls were hung a number of enlarged and coloured drawings of British and exotic plants, and diagrams illustrative of some of the important facts of botany. The plants added largely to the beauty of the exhibition. The feathery leaves of the ferns—of which there were some rare varieties, contributed by Mr. Conway and Mr. Yates—the beautiful foliage of the begonias, calladiums, and other plants, contrasted with the dresses of the brilliant audience, and relieved the glare of the gaslight, giving an effect at once grateful and pleasing. Mr. Hopkins, of the Temple Church, London, presided at the great organ, and during the evening gave the Minuet in "Samson" (Handel), Mozart's "Splendente te Deum," and other selections from Mozart, Mendelssohn, Weber, Hesse, &c.

Shortly after eight o'clock, Professor PHILLIPS ascended the platform, and after gratefully acknowledging the exertions of the Manchester officers of the Association, introduced Dr. Lankester, the secretary of the zoological and botanical section, to the meeting.

Dr. LANKESTER, who was received with applause, said he had been requested to say a few words that evening on behalf of the Association, and on behalf of natural history. On behalf of the Association, he was proud of the beautiful exhibition of objects of natural history which they had been invited to see that evening by the Field Naturalists' Society of Manchester. On behalf of natural history, and of the various branches of science included in that term, he claimed their serious attention, and their earnest cultivation of that science in the future. It had been a great pleasure to all present to find that, in the midst of this mass of smoke—in the midst of these tall chimneys, there was still a heart beating in sympathy with green fields, with the beautiful flowers, and with all the charms which carried us away from this great city.—(Applause.) They were delighted to find that in the midst of this great city, a club—a field naturalists' club—had been established; not a club of dry scientific students, who studied their specimens in their closets with their books—(laughter),—but a club of men and women with hearts fresh enough to glow with delight when they met the green fields and the bright flowers, and the beautiful creatures, with which God had adorned the earth.—(Applause.) He would just say here a few words on behalf of this Association. He held in his hand a prospectus which said it was a young Society, not boasting much more than a single year's growth—a mere babe in arms, in fact, 18 months old, but having, however, seen two summers; and the object of this youthful association had been to acquire a knowledge of natural history. For this, as he had said before, they had gone forth to the rocks and the hills and the fields of their neighbourhood, and he was delighted to read the detailed results which had been put into his hand in the form of a rather formidable-looking annual report. He was delighted to hear that in the excursions of the year the members had mustered in considerable numbers, and had derived considerable profit. He was delighted to see and to find that this field naturalists' club did not confine itself to one sex, but that ladies were permitted to join the excursions.—(Applause.) Although the weather had not always been favourable—(laughter)—and sometimes only one lady had joined the excursions, yet when a fine day did occur they came out like butterflies, and almost eclipsed the butterflies themselves.—(Laughter and applause.) Now, if there were nothing more than this pleasant social intercourse, he thought that would be a justification of the Field Naturalists' Club.—(Hear, hear.) But there was a good deal more; for, though some of the excursionists might fix their attention more on the pic-nic basket than on the flowers and the rocks—(laughter),—still they had been drawn away from the town, and there was some knowledge acquired, and some natural taste formed, which would probably bear fruit at some future time.—(Applause.) This was the case with all science. No one, no matter how ignorant, could come to one of their lectures but he learnt something. If he saw these diagrams and these figures, and did not understand them, he saw those who had acquired the knowledge, and he respected them, and thus if they had not made a friend they had probably made one opponent the less.—(Applause.) They had a natural history branch in the British Association, and they announced themselves by the somewhat repulsive name of the "Zoological and Botanical Section." And these might be made most repulsive sciences. If they brought a few dried animals out of the museum, and told the people they had long hard names derived from the Latin and from the Greek, they had probably done as much as they possibly could to disgust the public mind with zoology and botany. But the things now dried once lived, and the things with these hard names once breathed,

This, natural history taught. They might complain of the Greek and Latin names given to plants, in the science of botany; but let him call their attention to this point. When they found a particular form of a particular object, they would say at once, "This particular form must have a name." We had not English names for all. The simple, familiar names, such as "Forget-me-not," and "Heartsease" were soon exhausted. And these Greek names were just as easy as their own English, if they would only take the trouble to learn. They had three syllables, just like their own language.—(Applause.) Then let them come with him to the fields—come with a book of British botany in their hands. Let them come to the fields, and see what they could do. He would tell them what they could do. In the first place, let them pick up a flower, and study its structure—take up a daisy, and look at its leaves and its stem, and see how it differed from other plants—put it under a microscope, and observe its beautiful structure in various parts. The result would be to make them better acquainted with the daisy, and to prepare their minds for observation, and to give them powers which they previously did not possess.—(Applause). What they complained of was that the public and those interested in the education of the young did not do botany justice. Nowhere were chemistry and botany taught with half the perseverance which was bestowed upon Greek and mathematics.—(Hear, hear.) He would ask them to do this; he would ask them to study botany, because of its practical value. The men of Manchester knew something of the value of cotton. Cotton was a vegetable production, capable of being cultivated with as much greater advantage as wheat was now, compared with times past.—(Hear, hear.) So with regard to flax and other materials of manufacture. Botanists had long ago asked the manufacturers of Manchester to supply themselves with cotton from some other country than America.—(Hear, hear.) On that point at least botanists were free from blame.—(Applause.) Twenty-five years ago, he remembered General Briggs reading a paper—he (Dr. Lankester) having assisted him in getting up the details—pointing out British India as the source of the cottton supply for Lancashire.—(Cheers.) Some time afterwards, he himself came down to Manchester to draw attention to the Cape of Good Hope and Algoa Bay as the places for the cultivation of cotton. And if manufacturers were now going to work short time, and to shut up their mills for four days a week, he said it was because they had not studied natural history.—(Applause.) He might go on to say that there was a case there before him which contained a number of productions of great importance, and from which we derived great advantage. All of these might be produced with much greater facilities if those engaged in their culture and their sale knew more of the nature of the plants. Thus did they find that botany, this despised science, might be made one of the most useful.—(Applause.) One word or two in conclusion respecting the connection of science and religion. They had been preached to whilst they had been in Manchester. He would just say that men of science felt that as natural science became degraded, and became less esteemed, religion would lapse to superstition and rationalism; and it was only as they gave natural science to their sons and daughters, and taught them to become appreciators of its true principles, that they could become true disciples of that religion which, like natural science, came from the one true God.—(Loud and continued cheering.)

WEDNESDAY, SEPT. 11.

SECTION A.—MATHEMATICAL & PHYSICAL SCIENCE.

The section met at ten o'clock yesterday morning, the Rev. Mr. KIRKMAN in the chair. The ASTRONOMER ROYAL took the chair afterwards.

Mr. G. J. SYMONS read a paper "On British rainfalls." He stated that the rainfall of 1860 was about 1,500,000 of figures, and considerably above the mean at most stations, the average excess for previous years being 25 per cent. It was nearly 50 per cent in Herefordshire and some parts of the lake district, whilst at Manchester it was only three points in excess.—Some discussion took place on the question, in the course of which Mr. Valpy, Mr. Glaisher, and other gentlemen joined. Mr. GLAISHER dwelt at some length on the subject, showing that it was a highly practical question, and stated that the welfare of the people of this country depended, in a main degree, upon an accurate knowledge of the subject.

Mr. DAWSON, of Liverpool, next read a paper "On the law of universal storms." In the course of his paper the author laid down a theory incident to storms, and the regularity and occurrence of them when happening. In a lengthened and elaborate statement, he endeavoured to show that it was something like infatuation on the part of seafaring men ignoring the phases of nautical laws, and stated that, so far as he had been enabled to form an opinion on the subject, it amounted to nothing less than obstinate folly on the part of captains and seamen, who declined to act on the theory of those laws. He was not going to say that all the nautical theories hitherto advanced were to be taken as a guide by those who had to encounter the perils of the waves—for in a majority of instances it must be conceded that those who were the masters of ships were best enabled individually to judge, but he could not disguise from himself the truth that it was a most lamentable fact, and one which showed, in a painful degree, the recklessness of our mercantile marine—captains and commanders, as well as ordinary seamen included—that they would not believe in or act upon these laws; but, on the other hand, so far as the result of practical experience enabled the world to judge, they could not be induced generally to adopt them. It was a point of the greatest importance, at the present time, to consider whether it was not desirable to adopt improved means to secure the safety of traffic, leaving the rapidity of ships' passages as a secondary ingredient; and supposing this view of the subject to be recognised, it was worthy of being taken into account whether the theory of what was now nautically known as the "great circle sailing," was not the best to be adopted by our mercantile marine captains generally. He knew that in insisting upon the practical utility of recognising this theory he was in antagonism with the views of many experienced seamen, whose views were entitled to a profound amount of respect; but he nevertheless ventured to suggest, as worthy of the notice of the section and the nautical public generally, that in a great number of cases, ships whose captains had followed the "great circle sailing" theory, had arrived safely at their respective destinations; whilst other vessels, under the same conditions of thermometer and barometrical circumstances, but whose commanders had adhered to the hitherto received ideas of practical nautical navigation, had met with a fate which it would only be painful to dilate upon. He was firmly persuaded that until the principle of "circular sailing" was practically adopted by the masters and commanders in connection with our mercantile marine, we should in vain look for an average amount of safety and security as regarded our ships and their crews; and, entertaining, as he did most strongly, these views, he did not think that he could too warmly enforce upon the attention of the section, whose duties were so peculiarly identified with grave mathematical questions, the vital interest of this practical subject. Referring to the length and duration of storms, he said that the results of several of the most minute calculations indicated that in the instances of storms several of them had been noted down, showing that they extended as far as 3,800 miles, and travelled at the rate of 50 miles an hour. This was a moderate calculation, and by many, indeed, regarded as below, rather than above, the average. All new theories must, of necessity, if not actually discarded, be subject to considerable doubt and discussion, before being finally received or rejected; and he felt that the theory which he had endeavoured to explain must undergo the ordeal of public scrutiny; but, in the interest of that large number of our fellow-creatures whose lot was cast upon the seas, he urged upon the reflecting public the imperative necessity of the natural laws of storms being more widely and popularly studied.

Professor THOMSON read a paper, communicated by Professor Rogers, on "Physical considerations regarding the possible age of the sun's heat." The paper stated that, although mechanical power was indestructible, there was a universal tendency to its dispersion, which produced augmentation and diffusion of heat. Fortunately the earth was not finite, and left to the agency of existing laws, otherwise the result would be a state of universal rest and death.

Sir W. ROWAN HAMILTON read a paper "On geometrical laws in space," which was followed by some discussion, in the course of which,

Several other papers having been read,

Professor STEVELLEY, the secretary to the section, said that the business was now finished, but since he came into the room the general secretary had handed him a paper from Admiral Fitzroy, which he wished to be brought before the section, but it was now impossible—it was too late. He, however, wished it to be conveyed to the Association that he desired the Government to send out a ship into the Pacific Ocean for the purpose of ascertaining the nature of the tides. He thought that such a subject, brought forward under the auspices of the Association, would command the attention of the Admiralty.

The PRESIDENT remarked that it was an old and a true saying that he who gives early gives twice, and it was applicable in the case now before them. If Admiral Fitzroy had communicated his paper in time, it would no doubt have been read, and received with considerable respect, because there could be no doubt that it was a communication of the greatest interest.

A vote of thanks having been passed to the President for the manner in which he had conducted the proceedings of the section,

The PRESIDENT acknowledged the compliment. He said he felt very much gratified by their kind approval of his conduct during the time that he had had the honour of presiding over the section. He need not say that on the part of the chairman there was required a combination of qualities. He must be in some measure acquainted with all the business brought before the section. He must also be possessed of those business qualities for which this country was so justly celebrated. So far as his duties had been concerned the question of order had been a very simple one indeed. It had, of course,

been necessary for him to exercise a portion of the authority with which they had invested him, and in doing so some of them might, perhaps, have considered him somewhat harsh, but he had endeavoured to exercise it in a manner which he had thought was most desirable for the advantage of the section.—(Hear, hear.) He concluded by referring, in complimentary terms, to the officers of the section, whose duties had been heavy.

The business of the section was brought to a close at one o'clock.

SECTION C.—GEOLOGY.

The concluding meeting of this section was held in the theatre of the Royal Institution, Mosley-street; Sir R. I. MURCHISON, chairman of the section, presiding.

THE IMPERIAL GEOLOGICAL INSTITUTION OF VIENNA.

Sir R. I. MURCHISON, in communicating "information from Haidinger, respecting the present state of the Imperial Geological Institution of Vienna," said that important institution was one of many which were very likely to have been abolished in the course of the changes which were going on in the empire of Austria. That excellent institution was founded by his (Sir Roderick) distinguished friend Haidinger, one of the first geologists in Europe, who now wrote that the government having been changed, and public opinion having been expressed so strongly in favour of his institution, the government had conceded all the terms in favour of geological science which had been formerly granted; and the Imperial and Royal Geological Institution of Vienna was reinstated upon its old foundation.

CARBONIFEROUS LIMESTONE.

The CHAIRMAN next proceeded to give a few "Details of the carboniferous limestone, as laid open by the railway cutting and tunnel near Almondsbury, north of Bristol," forwarded by Mr. Richardson, C.E. Geologists obtained a great deal of very available and useful knowledge from the examination of the cuttings and tunnels in railroads; and he (the Chairman) was not aware that they had anywhere, of late years, derived more information from a single cutting than that to which he would point their attention. There was a branch railway making from Bristol, from the Great Western line, and which was to traverse the Severn on its passage. In making this traverse, it was necessary to go across a ridge of limestone—the Almondsbury, the railroad running across that country of carboniferous limestone. On the whole the strata were deep, and subject to very great contortions. In some parts there were broken bands of coal, thrown about in an extraordinary way. The whole of the highly-inclined strata were surmounted by new red sandstone. It was remarkable that there was in this cutting an enormous amount of calcareous and other grit, some bodies of which might be supposed to have formed a regular part of the mountain limestone. There were large masses of red substance, evidently formed by concretion.

A vote of thanks was accorded to Mr. Richardson. With respect to a "Report on examinations of minerals," by Mr. A. Gages, and a "Report of earthquake experiments," by Mr. R. Mallet, it was explained that such reports, though received at the section, were not read there, but would be printed in the next year's report.

SUBTERRANEAN MOVEMENTS.

Mr. HARKNESS, one of the secretaries of the section, read a communication, deferred from the previous day, "On subterranean movements," by Professor Vaughan, of Cincinnati. The Professor stated that the definite relations recently discovered between calorific and mechanical action seemed to have an important bearing on questions relating to the secular refrigeration of the earth and the high temperature of its internal regions, even at the present time. The vast amount of heat supposed to have escaped from our planet during past ages, might be reasonably expected to call into existence forces of much greater efficiency than those indicated by the upheaval of lands, or by the violence of earthquakes and mechanical eruptions. Our terrestrial fabric had a strength too limited for the full development of such great calorific powers by the unequal contractions of its different parts; and in a cooling globe compound gasses could not be expected to produce any decided mechanical effect, at least without materially altering the composition of the atmosphere. But, apart from these causes, the transition of the igneous rocks from a fluid to a solid state would be attended with occasional paroxysmal movement and change. Being dependent on hydrostatic conditions for stability, the different parts of the earth's crust must extend into the greater reservoir of lava to a depth in some measure proportionate to the elevation above its surface. Continents must rest on solid foundations far deeper than those which supported the body of the ocean; and the violence which subterranean forces manifested in several islands might be ascribed in part to the weakness of the barriers which restrained them. Inequalities in the solid envelope of our globe were indicated with some certainty by local forces of gravity. The anomalous character of the vibrations of the pendulum, when applied in some places, justified the conclusion that the invisible side of the earth's crust contained the greatest irregularities, and that our continental tracts of land rest on the bases of gigantic subterranean mountains, whose tops might be depressed even three or four hundred miles below the mean level of the rectified matter. The accumulations of solid matter on the internal mountains must ultimately be crushed by the strain which their augmented size occasioned; a mighty avalanche of rock would then tumble to the thinner part of the earth's crust. Regarding these masses as the cause of earthquakes, they might account for the instantaneous manner in which the shocks of earthquakes occurred, their extreme violence, and destructive character near the coasts of continents and on adjacent islands, while they were almost imperceptible in the interior of continents. It was probable that the ascending movements of silica, and perhaps of other isolated matter, might serve to bring the heavy metallic deposits from the central to the superficial regions of our planet; and the general occurrence of gold in auriferous quartz rock might thus admit of plausible explanation.—After a very brief discussion, in which Mr. PENGELLY questioned that the earth had ever been in a liquid condition, a vote of thanks was passed to the author of the paper.

THE INTERNAL HEAT OF THE GLOBE.

Professor ROGERS read a few extracts from a paper by Professor W. Thomson, entitled, "An examination of some points in the doctrine of the internal heat of the globe." The chief points advanced are referred to in the following discussion, which ensued after the reading of the communication:—Professor HENNESSEY said the geological bearing of the paper was simply to account for the former very high temperature that appeared to have existed at the earth's surface; or the great difference between the climate at present existing and that which was revealed to us by the presence of organic remains in certain portions of the earth, which could not have been there unless a very different climate had existed at remote epochs from that which now existed. What connection this had with our solar system, and the possibility of the sun decreasing in its calorific power, was a point of great importance; but he (Mr. Hennessey) would beg to observe that it was not competent fully to account for all the phenomena which were disclosed by geology. The result of very high temperature would, of course, be to increase the heat very much in the tropical parts of the earth, without a very much corresponding increase towards the polar regions. As far as he could learn, the tendency of early geology went to prove that a greater uniformity of heat existed at those remote epochs than existed at the present; whereas the conclusion to be arrived at from the paper just read would be that, on the contrary, a much greater diversity of temperature existed at former epochs. There

might be an interior source of temperature, such as that pointed out by Sir Charles Lyell, which might possibly influence the surface. Mr. Thomson stated that the heating power of the materials of the earth's crust would not alone sufficiently account for the temperature of the earth at remote epochs, but that they should account for it, perhaps, by the influence of moisture, thermal springs, and other sources. The examination of temperature in mines and other localities showed that the increase of temperature in descending from the earth's surface towards the interior depended not merely on the conductive power of the material, but in the predominancy of moisture, or the passage of vapours through the fissures and the general structure of the rocks. Mr. Thomson had referred to the astronomical existence of the possibility of our earth acquiring a higher degree of temperature by passage amongst a great number of stars at a former epoch. That question was settled immediately by this consideration—if it had passed sufficiently near to any star or stars to acquire such a very high temperature, the rims would practically form a double star; and if any considerable elevation of temperature resulted, and any thermal influence, there would also be communicated the gravitating influence. There was good reason to believe that at no former epoch of the earth's existence did we approach sufficiently near to any star to allow those bodies to greatly influence our temperature.—Mr. Pengelly doubted very much whether there was any evidence to show the previous higher temperature of the earth.—Mr. Symonds said there was very strong proof that some of the most ancient geological remains had been deposited without any very high temperature.—Mr. Jukes argued from the appearance of ancient rocks that the state of the globe had been very much, in all essential particulars, in the condition in which it was now even in the earliest geological periods.—Mr. Gages remarked that the atmosphere modified very considerably the conditions of the temperature of the earth, and, of course, that would affect the fossils found in it.—Professor Rogers said there was no questioning the influence of changes in the thermal condition of the earth. There was evidence of a far larger amount of moisture in the earlier ages; and the earth must have been fully ten times as rich in the carboniferous element as at present.—After a few remarks from Professor Hennessey, the Chairman remarked that he, in common with Sedgwick, Buckland, Professor Forbes, and a host of other geologists, were not of the school of the present day. They believed implicitly, from observations of large parts of the globe, that the intensity of causation in former times was infinitely greater than that which now prevailed.—(Hear, hear.) "Catastrophes," as they were termed by the geologists of the old school, were then referred to by the Chairman, who said that in the Alps he had seen a mountain which had evidently been completely overturned. In the words of Mr. Harcourt, "the nature, force, and progress of the past condition of the earth could not be measured by its existing condition."—The discussion then terminated, Mr. Thomson receiving a vote of thanks.

THE EXTINCT VOLCANOES OF WESTERN VICTORIA.

Mr. James Bonwick read a paper on this district. Having lately visited the extinct volcanoes of Italy and France, as well as having observed the active cone of Vesuvius, the author did not think he was wrong in calling the south-western part of Victoria and the adjacent portion of South Australia the burnt fields of Australia. The country referred to lies chiefly between the slate and granite dividing range of the diggings and the tertiary limestone of the sea coast, having an area of nearly half the size of England. It extends from the Bay of Port Phillip, near Melbourne, and Geelong, to beyond the western border of Victoria, by the Glenelg. The great basaltic plain of the west has few interruptions from the bay to the border, and from the shore to the central range. The basalt is of all varieties, and furnishes in its decomposition the finest soil to the agriculturist. It has been an island of basalt in a sea of slate, so to speak, which abounds with farms, though surrounded by heartless woods and shingle soil. Many mammeloidal lava hills are found on the plateau of the dividing range. Caverns, nearly 500 feet in length, exist in the basaltic floor of the plains. On the south-west side of the great salt lake Corangamite, there are basaltic rises. These are huge barriers from 10 to 60 feet in height, forming a vast labyrinth of rocks, 15 miles long by 12 broad. The natives in olden times retreated to these inaccessible retreats, with the sheep they stole from the flocks in the neighbourhood. The ash or sufa has the same appearances as those the author observed at Lake Albano, near Rome, and at Pompeii. It is occasionally sufficiently solidified to become building stone. Carvings, however, are very commonly made of it in the district. The ash and cinder conglomerate exists but in one place—on the Island of Lawrence, in the Portland Bay. Cliffs of this singular compound rise there 150 feet. The author's impression is, that the source was a submarine volcano to the south west—the course of the prevailing wind and current; and that the ashes and volcanic dust were received in some sheltered bay, since raised with the coast. The extinct volcanoes are in the form of lakes and mountains. The lakes are depressions usually on slight eminences. Terang, Elingamite, Purrumbete, Wangoon, and Lower Hill are fresh; while Keilambete and Bullenmerri are salt. The shallow saline lakes of the plains were not former craters. The depths of some of these lakes are 50, 100, 150, 200, and 300 feet. The Devil's Inkstand of Mount Gambier is 260 feet. The banks vary from a few feet to 300 feet in height above the water. The circumference varies from a hundred yards to seven miles. The thickness of the ash increases with the distance from the crater, but is always thickest on the eastern side. At Lower Hill, at a quarter of a mile from the bank, on the northern quarter, it is 80ft. deep, while at a mile off, on the eastern side, it is 150ft. The volcanic hills vary from a few yards to above 2,000ft. above the sea level. The depth of the dry craters runs from 50ft. to 300ft. Gambier and Schanck are within the South Australian border. The former has three fine lakes. The latter is a dry basin, known as the Devil's Punchbowl. Porndon is a cone of very light cinder, rising amidst the remarkable rises. Leura is a broken crater on the edge of the rises; while Purrumbete is a beautiful sheet of water, a few miles distant, which once, as a crater, discharged vast quantities of ash. The other principal volcanoes of Western Victoria are Buninyong, Blowhard, Noorat, Gellibrand, Napier, Franklin, Cavern, Shadwell, Lower Hill, Clay, Elephant, Eckersley. No adequate impression can be received as to the age of the activity of these cones and craters. There is a freshness in most of them, indicative of a comparatively modern date. The natives have traditions of the eruptions of several of them. As loam overspreads the recently scattered auriferous drift of several of the diggings, it would not appear to have been of great date. It occurs on tertiary limestone to the west, and underlies it as well.

The Chairman, in adjourning the section, assured those present that he had never presided over its meetings on any occasion with more satisfaction. Their numerous discussions had been carried on in an excellent manner, and they had as many papers remaining as would have sufficed to occupy their attention during the remainder of the week.

On the motion of General Portlock, a vote of thanks to Sir R. J. Murchison, the chairman of the section, was carried by acclamation.

MEETING OF THE GENERAL COMMITTEE.

The General Committee met at one o'clock yesterday, in the Mayor's Parlour, at the Town Hall; William Fairbairn, Esq. LL.D. F.R.S. &c. president, in the chair. There was a numerous attendance. The minutes of the previous meeting were confirmed.—Mr. W. Hopkins, M.A. F.R.S. general secretary, said that at the last meeting it was decided that the Association should assemble next

year at Cambridge, but the time was not definitively fixed. One of two periods must be taken, about the end of June when the long vacation had commenced, or the end of September when the new term was about to commence. He believed that with regard to residents at the University, and upon whose kindness the Association must so much depend, the most convenient time would be the end of June, although there was reason to believe that the end of September would be most convenient for many non-resident members. It was, however, very important to consult the wishes of their resident members and friends, to whose kindness and attention the Association must naturally be greatly indebted; and his impression was that the great majority of these would be in favour of the end of June.—Professor SEDGWICK: I entirely agree with you, and upon the ground you have just stated.—Colonel SYKES said the matter was generally left to the Council.—Mr. HOPKINS said that it was intended to propose the same course now; and he would therefore move "That the time for holding the next meeting be fixed by the Council, after consultation with the local authorities at Cambridge."—Professor PHILLIPS seconded the motion.—Several members said that holding the meeting at the end of June had been found inconveniently early by many, although it was admitted that it was difficult or impossible to avoid, whether at Oxford or Aberdeen.—The motion was unanimously agreed to.

GRANTS FOR SCIENTIFIC PURPOSES.

Professor PHILLIPS read the report of the Committee of Recommendations as far as money grants are involved, and which we believe includes all the recommendations from the several sections. The recommendations were—

That £500 be appropriated, under the direction of the Council, for maintaining the establishment at Kew.

That £40 be granted to the Kew Committee, for the employment of the photo-heliometer.

That the co-operation of the Royal Society be requested in obtaining a series of photographic pictures of the solar surface, and that £150 be granted for that purpose.

Colonel Sykes, Lord Wrottesley, Professor Airy, Sir D. Brewster, Sir J. Herschel, General Sabine, Dr. Lloyd, Admiral Fitzroy, Dr. Lee, Dr. Robinson, Mr. Gassiot, Mr. Glaisher, Dr. Tyndall, and Dr. Miller, to form a Balloon Committee—£200.

Professors Williamson, Wheatstone, William Thompson, and Miller (Cambridge), Dr. Matthiessen, and Mr. F. Jenkin, to be a Committee to report upon the standards of electrical resistance—£50.

Messrs. J. Glaisher, R. P. Greg, E. J. Bayley, and Sir J. Herschel, to report upon luminous meteors and aerolites—£20.

Mr. F. Jenkin, to continue his experiments for determining the laws of permanent thermo-electrical currents in broken metallic circuits, and to report—£20.

Professor Hennessey, Admiral Fitzroy, and Mr. Glaisher, to study, by the aid of instruments specially devised for the purpose, the connection of small vertical disturbances of the atmosphere in storms—£20.

M. Gages, to continue his researches on the mechanico chemical analysis of minerals; £8 remaining from the last year's grant to be placed at his disposal.

Dr. Hooker, Mr. E. W. Binney, and Professor Morris, to prepare a report illustrating the connection between the external form and the internal microscopical structure of the fossil wood from the lower coal measures of Lancashire—£40.

Sir C. F. Bunbury, Mr. Binney, and Mr. Ormerod, to report on the flora of the Lancashire coalfield—£40.

Mr. R. H. Scott, Sir R. Griffith, and the Rev. Professor Haughton, to report on the chemical and mineralogical composition of the granites of Donegal and the rocks associated therewith—£25.

Mr. J. G. Jeffrey, Mr. Alder, and the Rev. T. Hincks, to dredge the Dagger Bank, and other portions of the sea on the coast of Durham and Northumberland—£25.

Mr. Jeffrey, Dr. Dickie, Professor Nicol, Dr. Dyce, and Dr. Ogilvie, to dredge on the north and east coasts of Scotland—£25.

Mr. Jeffrey, Dr. Kinahan, Dr. Carter, and Mr. R. Walker, to conclude the dredging report on the Bay of Dublin—£15.

Mr. Jeffrey, Dr. Cleland, Mr. Byerley, and the Rev. H. H. Higgins, to dredge the Mersey and the Dee—£5.

Mr. Jeffrey, Dr. Lukis, Mr. C. S. Bate, Mr. A. Hancock, Dr. Verloren, and Professor Archer, to report on the best method of preventing the ravages of the teredo and other animals on our ships and harbours—£10.

Mr. P. S. Sclater, Mr. R. J. Tomes, and Dr. Gunther, to report on the present state of our knowledge of the West Indian vertebratæ—£10

Mr. Sclater and Dr. Hochstetter, to continue their investigations as to the species Apteryx, in New Zealand—£50.

Dr. E. P. Wright and Mr. W. H. Harvey, to report on the fishes of Dublin Bay and the coast of Leinster—£15.

Mr. Sclater and Dr. E. P. Wright to assist Mr. Carpenter in preparing a supplementary report on the mollusca of the north-western coast of America—£10.

A committee, consisting of Dr. Collingwood, and other gentlemen, to be appointed to report on collecting objects of natural history by the mercantile marine—£5.

Dr. E. Smith and Mr. W. R. Milner, to continue their inquiries into the influence of prison dietary and discipline over the bodily functions of prisoners—£20.

Mr. T. Webster, the Right Hon. J. R. Napier, Sir William Armstrong, Mr. W. Fairbairn, Mr. W. R. Grove, Mr. James Heywood, and General Sabine, to take such steps as may appear expedient for rendering the Patent Laws more efficient for the reward of the meritorious inventor, and the advancement of practical science—£30.

£15 to be paid to Professor Thompson (Belfast), to meet the outlay incurred in the experiments on gauging water, now completed.

Mr. W. Fairbairn, Mr. J. E. M'Connel, and Mr. William Smith, to report on some of the causes of accidents on railways, more particularly those accidents consequent upon the failure of the materials and apparatus used in the construction and working of railways and in the railway stock—£25.

The Committee on Ship Performance to be re-appointed. That their attention be also directed to obtaining information respecting the performances of vessels under sail, with a view to comparing the results of the two powers of wind and steam, in order to their more effective combination—£150. The Committee to consist of the Duke of Sutherland, the Earl of Gifford, the Earl of Caithness, Lord Dufferin, Mr. Fairbairn, Mr. J. Scott Russell, Admiral Paris, the Hon. Captain Egerton, R.N., the Hon. L. A. Ellis, M.P., Mr. J. E. M'Connel, Mr. W. Smith, Mr. J. M. Rankine, Mr. James R. Napier, and Mr. Richard Roberts; Mr. Henry Wright being requested to act as secretary.

Mr. J. Oldham, Mr. J. F. Bateman, Mr. J. S. Russell, and Mr. T. Thomson, to conduct a series of tidal observations in the Humber—£25.

£600 to be appropriated, under the direction of the Council, to the printing of the Index to the Transactions of the Society for thirty years.

£100 to be granted to Professor Phillips, for the employment of an assistant for the year.

It was explained that in each case the money would be drawn by the gentlemen first named.

Mr. PHILLIPS also read the recommendations of the Committee not involving money grants, as follow:—

Professor Stokes to continue his report on physical optics.

Mr. Cayley to continue report on the solution of certain problems of dynamics.

Mr. A. Smith and Dr. Evans to examine the three reports of the Liverpool Compass Committee, and other publications on the same subject, and to report.

Professor Storey to report on the present state of molecular physics.

Dr. Lloyd, and others, to report on Gauss's theory of magnetism and magnetical variations, and on the general application of the same.

Dr. Robinson, and others, to apply to the Board of Trade for permission to make experiments with regard to sound signals during fogs at sea.

Dr. Lloyd's paper on magnetic changes to be printed amongst the reports.

The report of Mr. Schunck, Dr. A. Smith, and Professor Roscoe, on the recent progress of the chemical manufactures of South Lancashire to be printed.

Professor Calvert's papers on the chemical composition of steel, and the properties of woods used in the dock yards, to be printed.

Professor Williamson, and others, to report on the registration and publication of the numerical facts of chemistry.

Professor Williamson, and others, to report on any improvements that can be suggested with regard to taking scientific evidence in courts of law.

Mr. Foster to report on Muscular Irritability.

Dr. Davy, and others, to be a committee to represent to the India Office that it would be advantageous if inquiries, similar to those of Dr. Mouat in his report on the prisons of Bengal, were undertaken in other provinces, especially the Punjab, and other north-western provinces.

Mr. Hunt's paper on the Acclimatisation of Man to be printed.

Admiral Sir E. Belcher, and others, to report on the rise and progress of steam navigation in the port of London.

Mr. Fairbairn, Mr. Bateman, and Mr. Lando to report on the experiments being made at the Manchester Waterworks on gauging.

Mr. C. Atherton's paper on freight as affected by the dynamic performances of steam ships, to be printed

Mr. Reed's paper on our iron-cased ships to be printed.

Mr. Webster, and others, to communicate with the Parliamentary Committee with regard to reform in the patent laws.

All the recommendations were confirmed, and the Committee then adjourned.

CONCLUDING GENERAL MEETING.

The concluding general meeting of members was held in the Free-trade Hall, at three o'clock, the great room being well filled, and a large number of ladies being present.—Mr. Fairbairn, the president, took the chair; and upon and near the platform were most of the leading members who have been attending the various meetings during the past week.

The President called on Professor Phillips to read the report of the General Committee.

Professor Phillips said that before proceeding, in obedience to the directions of the President, to make the meeting acquainted with the sum of what they had been attempting to accomplish in the course of the present week—in the matter of receiving money and distributing it, as well as in the matter of receiving information and requesting further information by means of reports on special subjects—he might be allowed to express a hope that they were all comfortably seated. Simple as this wish might appear, it had been a matter of no small anxiety to the local and other officers of the Association to obtain accommodation for their several meetings. Even that magnificent hall had been found inadequate for the attendants on the evening meeting, to hear the splendid discourse of Professor Airy: and on that occasion they had been obliged to ask permission to enclose a certain space, otherwise those who attended on special invitation would have had no chance of finding a place. In making this sort of apology, he might say it had always been his wish and the wish of the Association, except on business occasions, to make no distinction of places beyond what was necessary for the governing body. On one occasion—that of the lecture by Professor Miller, at the Concert Hall—he had himself been shut out, and was obliged to content himself with listening at the extreme end of the room. Upon the whole, he hoped everybody shared his extreme satisfaction with the accommodation which had been afforded them.—(Cheers.) And if any one thought that an improvement in this respect could be made, he hoped they would come and try at Cambridge.—(Cheers.) He would now state the results of the meeting. The gathering of such numbers of persons, and of such an amount of funds for the advancement of science, was very unusual. He thought that, upon the average of 30 years, the attendance of members at meetings of the British Association might be stated to amount to some 1,600 persons; and with regard to the sums of money gathered, he supposed that something under £2,000 might be the average each year. Now, on the present occasion, the numbers registered up to one o'clock that day were these:—Old life members, 321, here present; new life members who had joined them on this occasion, 180, who had paid them £1,800; old annual members had joined to the extent of 184, and by some unexplained act of generosity, they appeared to have paid £1 too much—(laughter)—they having paid £185. Then they had been joined by 119 new annual members, who had paid them £238. They had had associates to the number of 1,588, who had paid £1,588; and what, in their estimation, was more valuable than all the rest, 818 ladies had been presented with tickets of the value of £818; making, therefore, a total of members and associates who were on their books of 3,139—the sum of money which they had received, and all of which would be devoted to the advancement of science, being £3,905. The committees of the various sections had been considering in what manner they could best employ this money; and he proposed, therefore, to read to them the several grants which had passed the general Committee, and also the other recommendations of the Committee not involving grants. Professor Phillips then read the list, which appears in the report of the meeting of the general Committee. As to the £600 for the general index, he said that the matter was prepared in three great divisions. The people who had done the work; the places at which observations had been made; and the subjects written upon. The index would be very valuable; for, at present, there was nothing but an index for each of the 30 volumes of Transactions. He found that some members had joined but just now; and the whole sum received was £3,920, of which £2,363 had now been set aside for grants.—(Applause.)

The President said it was his pleasing duty to congratulate them upon the great success which had attended the present meeting. He assured them that no previous meeting had exceeded the present one in this respect, not on account merely of the number of members present, or on account of the money received, and which, he could assure them would be laid out in researches for scientific purposes, but also as regarded the value of the papers. In Section A they had had many papers of great interest and value, and on various subjects. In Section B there had also been many valuable papers, and one especially was the report on the chemical manufactures of the southern district of Lancashire. He was present and heard it with very great interest. Referring briefly to Sections C, D, and E, the President added that he heard the discussion in Section F on the principle of taxation; and, although he did not pretend to be a politician or to be versed in economical science, he was satisfied all would agree that that discussion was most valuable and important. With Section G he had always been closely connected since he had been a member of the Association; and he believed that upon no former occasion had papers of greater interest and importance to the country been read in that section than on the present occasion. First came the papers and discussion upon the Patent Laws, which every one interested must know were exceedingly defective; and he hoped that the result would be such a change as would give encouragement to the inventive talent of the country, and also give to meritorious inventors that protection to which they were justly entitled. He was not one of those who would give up or abandon the Patent Laws.—(Cheers.) He thought that the inventive creations of a man's mind were his own property; and that he ought to be paid for it if he brought forward an invention likely to prove beneficial to the nation at large.—(Applause.) He hoped that these laws would be modified; and he was sure that their friend, the Hon. Joseph Napier, would give his best assistance in effecting that object. Another subject discussed in Section G was of the greatest possible importance at the present moment. Our neighbours the French originated the use of thick iron plates for the defence of ships of war, and had practised it with considerable success, although, perhaps, not on so large a scale as in the case of our Warrior, Black Prince, and other ships. But still there was a degree of activity and energy on the part of the French Admiralty that left nothing undone that could be done to render their navy as complete as possible; and it was our duty, for the sake of our own security, not to be behind any country, but far in advance of all others.—(Cheers.) The discussion upon this subject, with the one upon improvements in Artillery, would, he hoped, lead to the best possible results. He could not conclude without alluding to the evening lectures and the soirées. He would particularly mention the address of Professor Miller "on Spectrum Analysis," which was so interesting in itself and so beautifully illustrated. They were deeply indebted to the Astronomer Royal—(cheers)—for his admirable address upon Eclipses; and to Mr. De la Rue, as well for his assistance in illustrating that address, as for the energy with which he had devoted himself to obtaining photographs of the sun's spots. Their thanks were due to Mr. Grove for the very lucid manner in which he addressed those present at the Telegraph Soiree, and for his history of telegraphy, from its commencement in this country to its present high state of improvement. Much remained to be done, especially as

regarded submarine telegraphy, not only in insulating the wires, but in safely laying them upon the bed of the ocean. He had been unable to be present on the previous evening in time to hear Dr. Lankester, but was sure that those who had the opportunity were highly gratified at the way in which that gentleman commented on the botanical specimens and the cases of natural history which were exhibited.—(Cheers.) After the close of this meeting, it was to be hoped that the Local Committee of the Association would arrange to give the working classes an opportunity of viewing these objects.—(Hear, hear.) He had now to conclude by proposing a vote of thanks, which he was sure was justly merited. Speaking as the organ of the British Association, he had the honour of requesting that the thanks of this body should now be expressed to the Local Executive Committee, in the first place; and also to the following gentlemen and institutions who had afforded material accommodation during the meeting:—The Mayors and Corporations of Manchester and Salford—(cheers);—the proprietors of the Portico—(cheers);—the Literary and Philosophical Society—(cheers);—the Council of the Royal Institution—(cheers);—the Directors of the Mechanics' Institution—(cheers);—and of the Manchester Athenæum—(cheers);—the proprietors of the Gentlemen's Concert Hall—(cheers);—of the Free-trade Hall—(cheers);—and of the Royal Exchange—(cheers);—the Trustees and Committee of the Friends' Meeting House—(cheers);—and of the New Jerusalem Church and Schools—(cheers);—the Trustees of Owens College—(cheers);—and also the several railway and steam packet companies who had issued return tickets to members coming from a distance.—(Cheers.) To all these, he tendered his sincere thanks, in the name of the Association, for the very deep obligation they were under.—(Hear, hear.) He could not sit down without noticing the very energetic and generous manner in which the whole of the local arrangements had been conducted for the personal comfort of the members of the Association.—(Cheers.) He was just reminded that a letter had been received from Miss Nightingale, expressing her thanks for the great interest which the Association had shown in the welfare of the British army.—(Cheers.) He was about to observe, however, with regard to the Local Executive Committee, that in their arrangements neither time nor money had been spared in order to do everything that possibly could be done for the convenience of every one attending the meeting.—(Hear, hear.) He was deeply indebted, personally, to the four local secretaries. (Cheers.) He did not believe there ever were secretaries appointed by any meeting or institution who did their work so well—(hear, hear)—or that any three or four men had ever worked together "as a team"—for it put him in mind of the old four-in-hand—(laughter)—with more zeal and perseverance in doing their duty, than had been displayed by the local secretaries of this meeting.—(Cheers.) He begged to congratulate them on the success of the meeting. He felt himself particularly indebted, not only to his own personal friends in Manchester, who had rallied around him in a manner he should never forget, but to all the members of the Association, whose kindness he deeply felt.—(Loud cheers.)

M. Curtis, Esq. Mayor, said that he felt it hardly fair to be called on to return thanks on the present occasion. That honour, he felt, was justly due to one of the four local secretaries. They, and they alone, he might almost say, had made the entire arrangements for the reception of the Association, and to them he, as a member of the Executive Committee and the General Committee, thought the expression of their thanks mainly due for the manner in which they had conducted the preliminary business. In behalf of himself and the Corporations of Manchester and Salford, he could only say it had afforded them extreme pleasure and satisfaction to find located in the city such distinguished members of the British Association.—(Cheers.) He trusted they had found that the authorities of the city had peformed as much as they had promised—(cheers)—when they gave the invitation to the Association, so far as accommodation was concerned.—(Cheers.) They were not in the habit of promising much; they trusted rather to their deeds and performances.—(Cheers.) If their performances had been acceptable, it would be highly gratifying to the municipal authorities. He regretted that the Mayor of Salford was not present to join him in this ackowledgment. He had left him about an hour ago going to Worsley to take part in an important ceremony—that of cutting the first sod of a new railway; and they had deputed each other to speak for both. He hoped that their meeting here would be productive of very pleasant reminiscences. He, individually, had had the pleasure of becoming acquainted with many gentlemen previously unknown to him, and he trusted that with some, at least, that acquaintance would ripen into something like friendship, and he hoped and trusted that this would be the the case with others. They would long remember with pleasure the meeting of the British Association in Manchester. He hoped that 19 years would not elapse again before they had the honour of again welcoming the Association here; and he assured them that if the Association should favour them with another meeting, they would endeavour to give them as hearty and as sincere a welcome as they had done on the present occasion.—(Cheers.)

Professor Airy, in moving a vote of thanks to the President, said it was unnecessary for him to point out the claims which Mr. Fairbairn possessed on their regards. He was well known in that place for his extensive knowledge of engineering, and his connection with some of the mightiest works which adorned the country. To those who lived at a distance, there were other parts of his career which called for their admiration. Among the other claims which Mr. Fairbairn possessed to their regards might be mentioned the admirable address which he had delivered to them a few days ago. They were aware that a great part of the business of the Association was transacted in sections, and there they had the benefit of Mr. Fairbairn's assistance. In the section over which he had had the honour of presiding; one of the most important communications was made by the President, in his private capacity as a member of the Association. But there was a great deal of other business which was not so well known to members generally, Mr. Phillips had read to him a list of the recommendations of the Committee. On all those occasions on which those questions were discussed, Mr. Fairbairn was present, and he examined them all in detail.—The vote was carried by acclamation.

The President, in acknowledging the vote, said it was not always a pleasant duty to speak of oneself; and he could only say that he felt he owed a deep debt of gratitude to the members for the way in which he had been received, and for the manner in which he had been supported. He felt exceedingly thankful, and should ever remember with the best feelings the Manchester meeting of 1861. The meeting would now stand adjourned to June next; and he hoped he should have the pleasure at Cambridge of seeing again many of the ladies and gentlemen who had attended the present, and had taken so much interest in its proceedings.

The meeting then separated.

EXCURSIONS

The excursions in connection with the Association took place on Thursday, and were to the following places;—The gardens at Worsley Hall; the Worsley Coal Mines; Astley Deep Pits, Dukinfield; the Great Marston Salt Mine, near Northwich; Glass and Chemical Works, at St. Helens; the Copper Mines, at Alderley; the Manchester Waterworks, from Woodhead; and Buxton.